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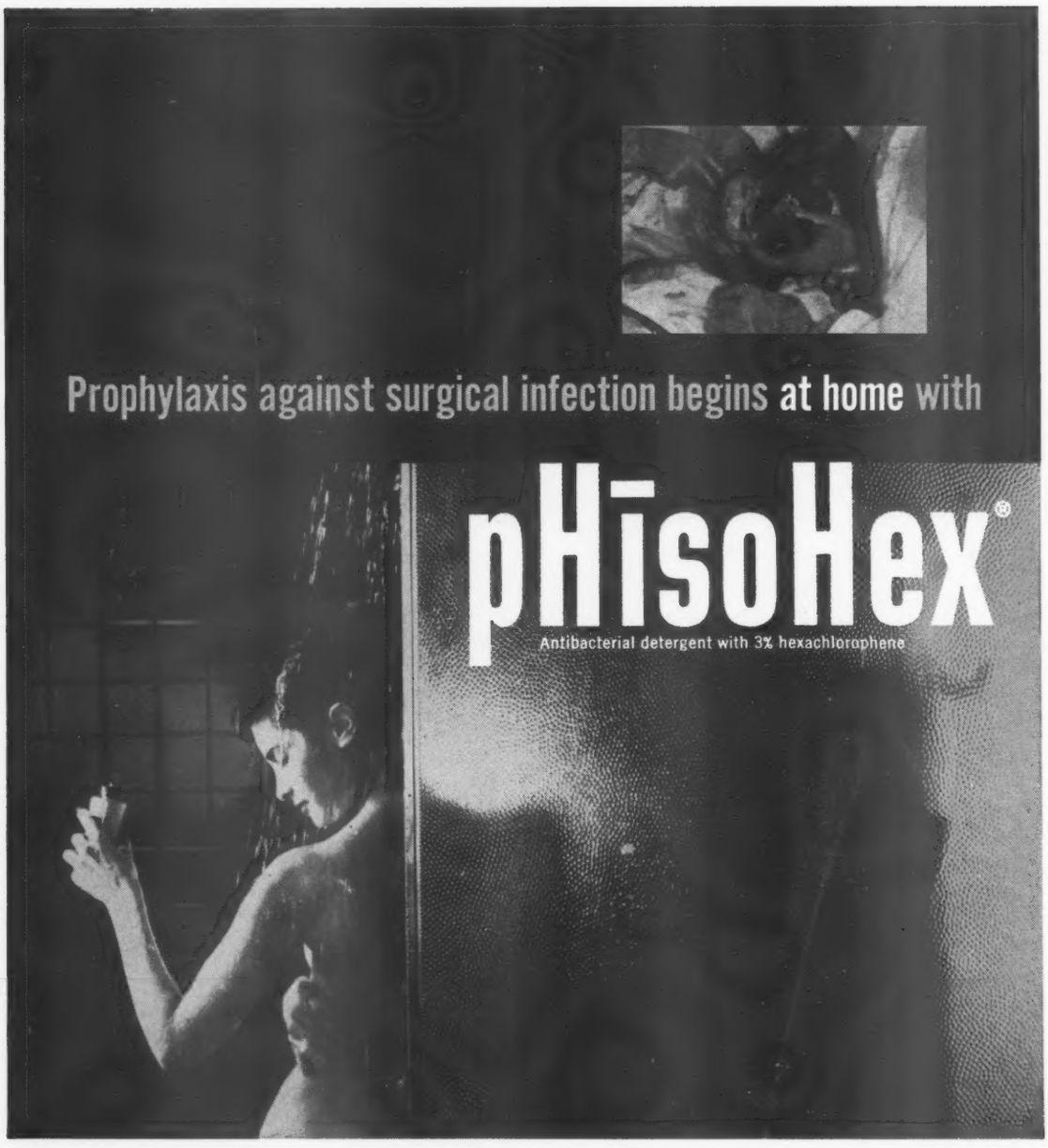
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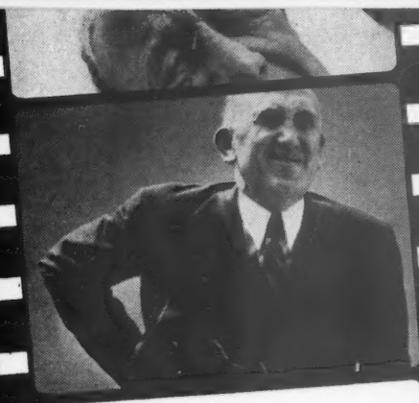

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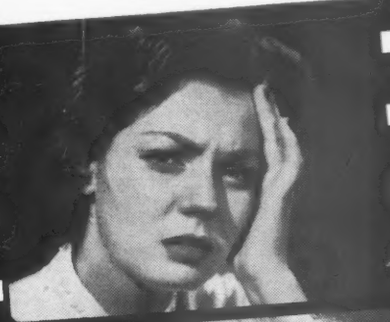

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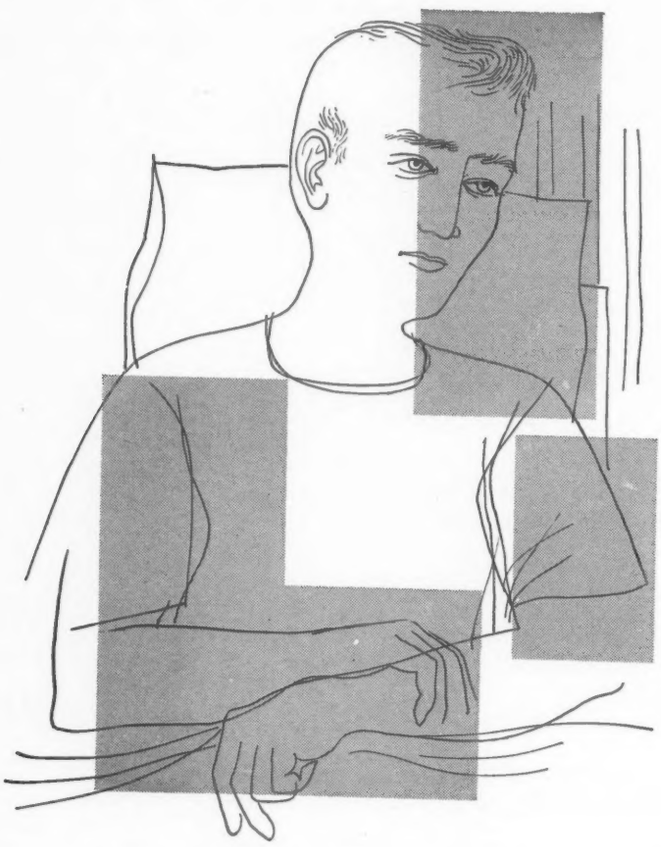

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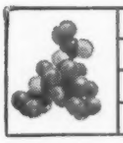

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2. *Lamphier, T. A.: The role of meprobamate in postoperative surgical care. Ann. New York Acad. Sc.* **67**:*810, May 9, 1957.*
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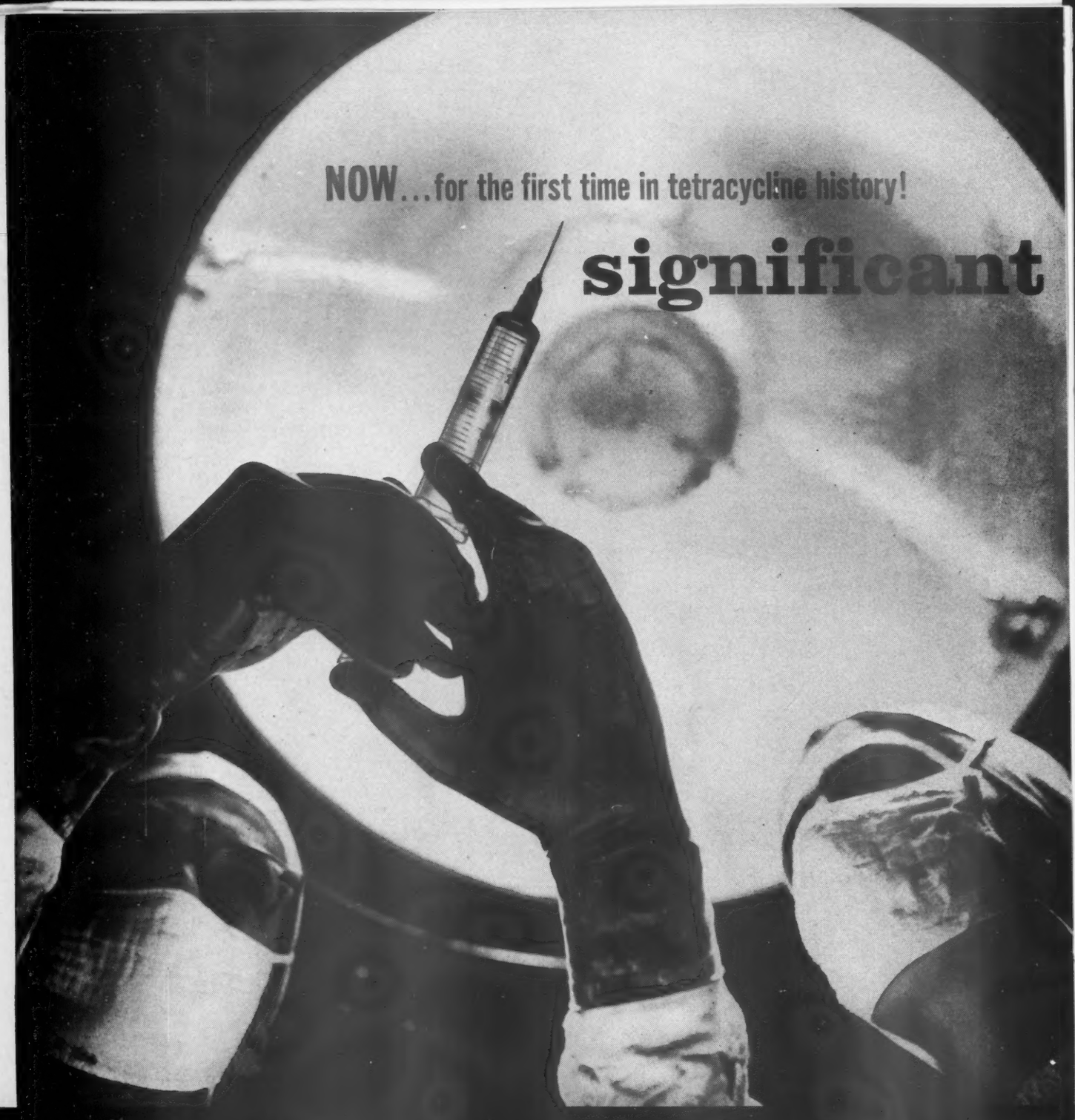

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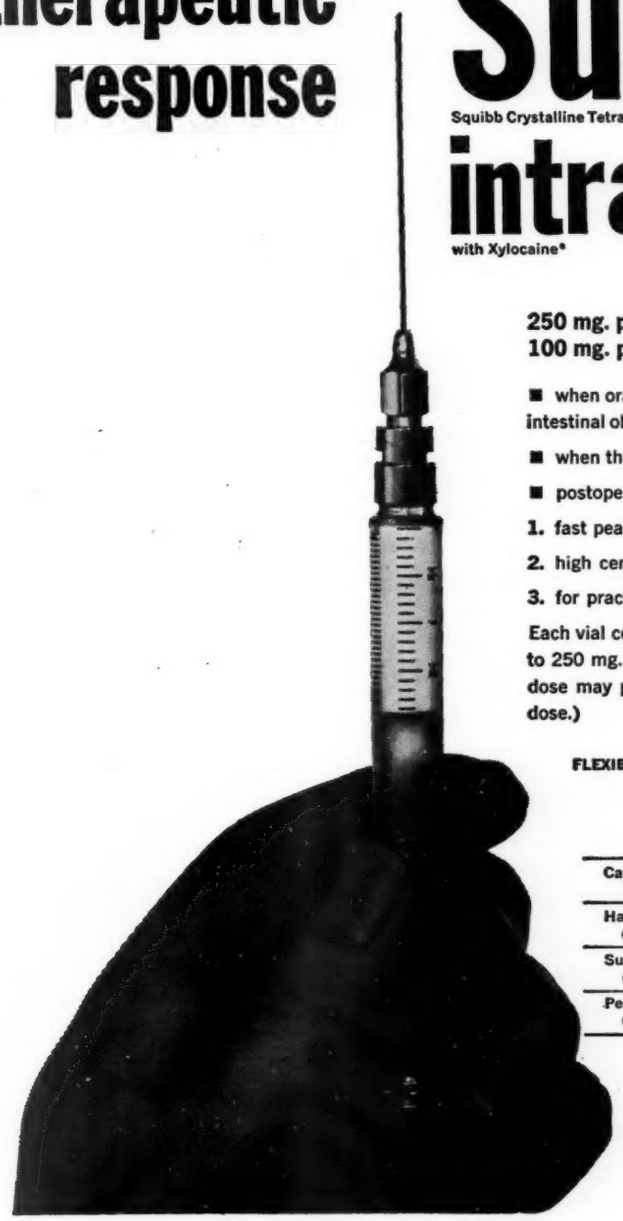

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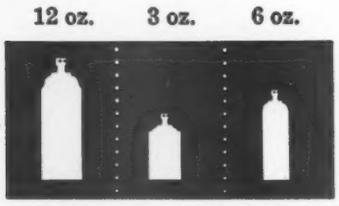

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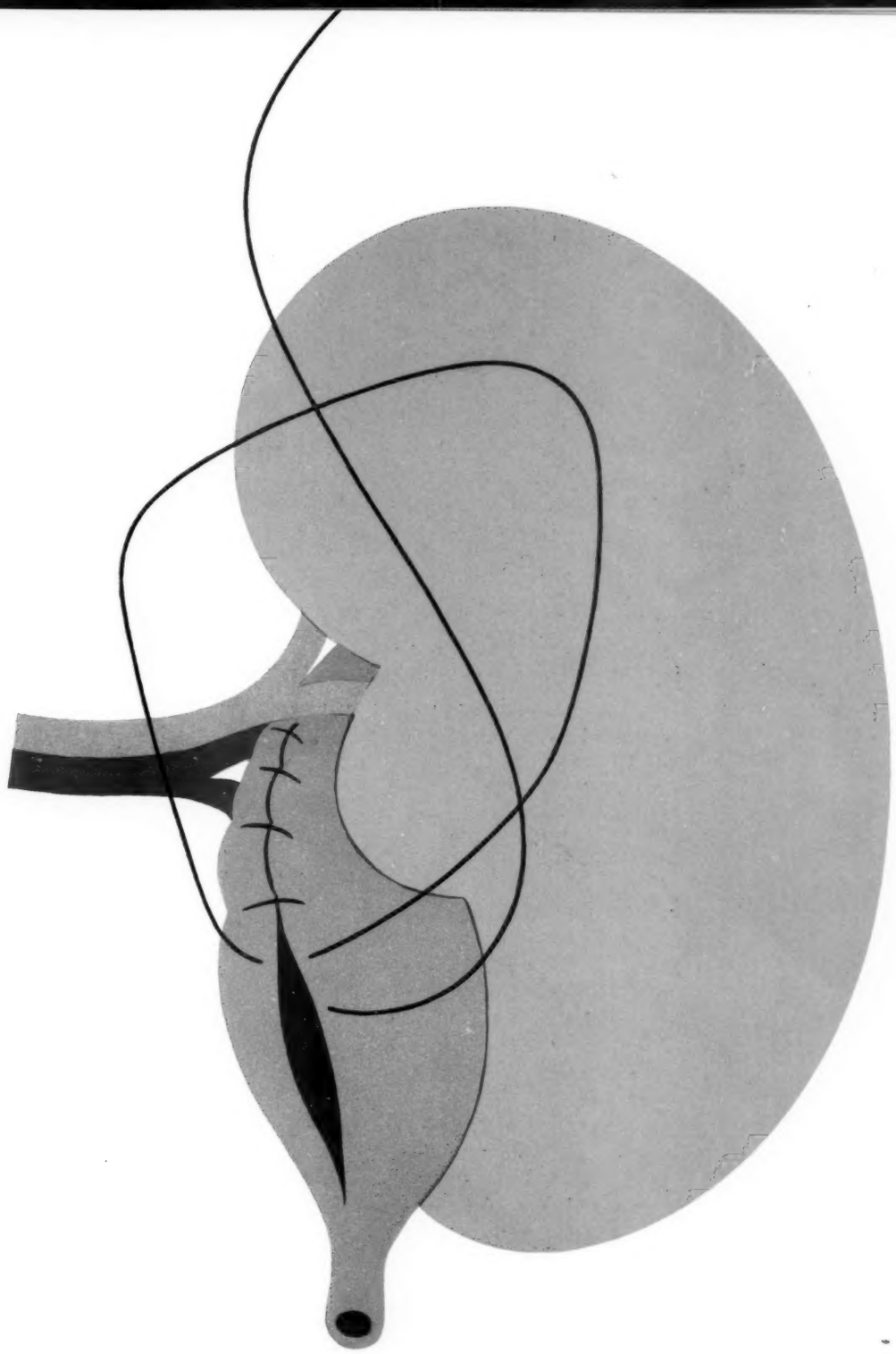

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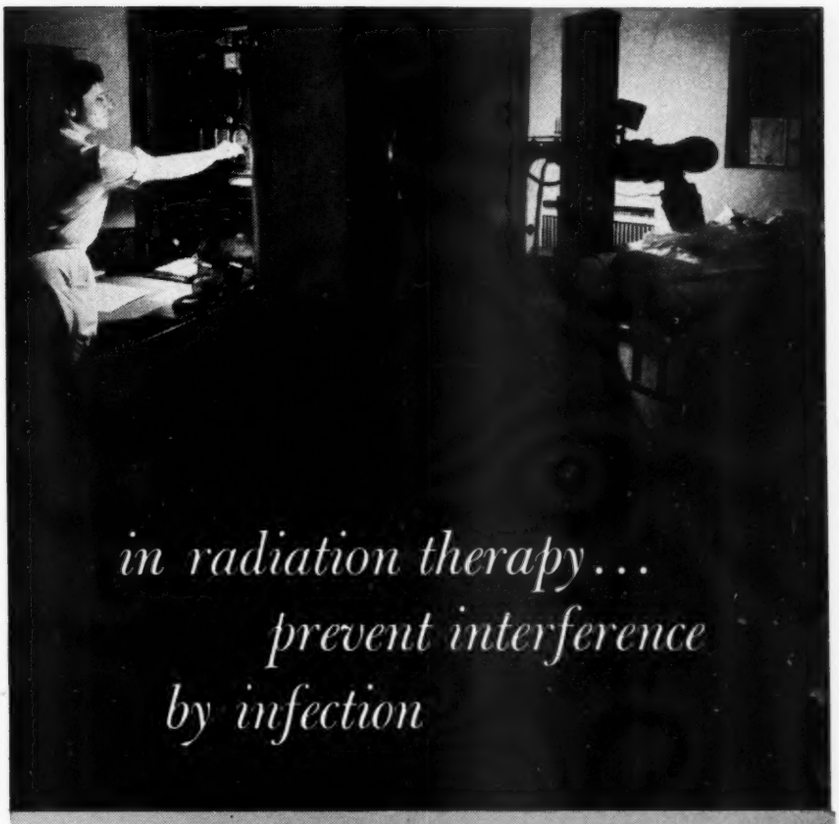

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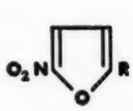

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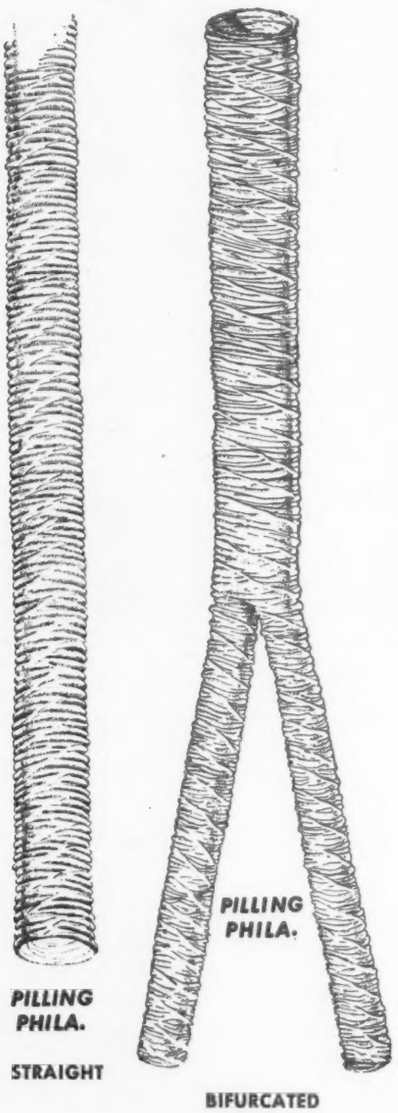

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1. DeBakey, M. E., Cooley, D. A., Morris, G. C. Jr., Collins, H.: Arteriovenous Fistula Involving the Abdominal Aorta, Annals of Surgery, *147*:646 (May, 1958)

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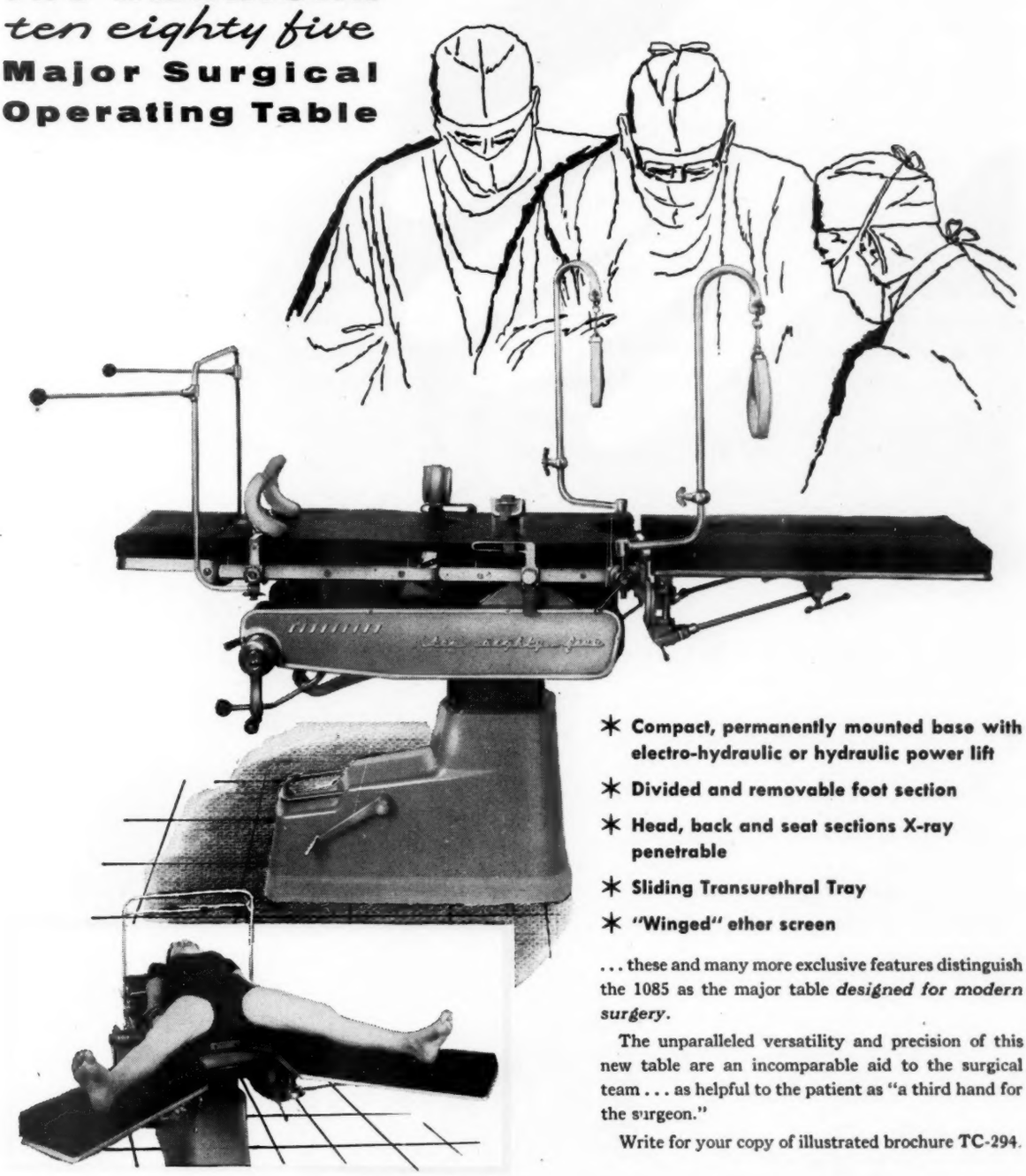

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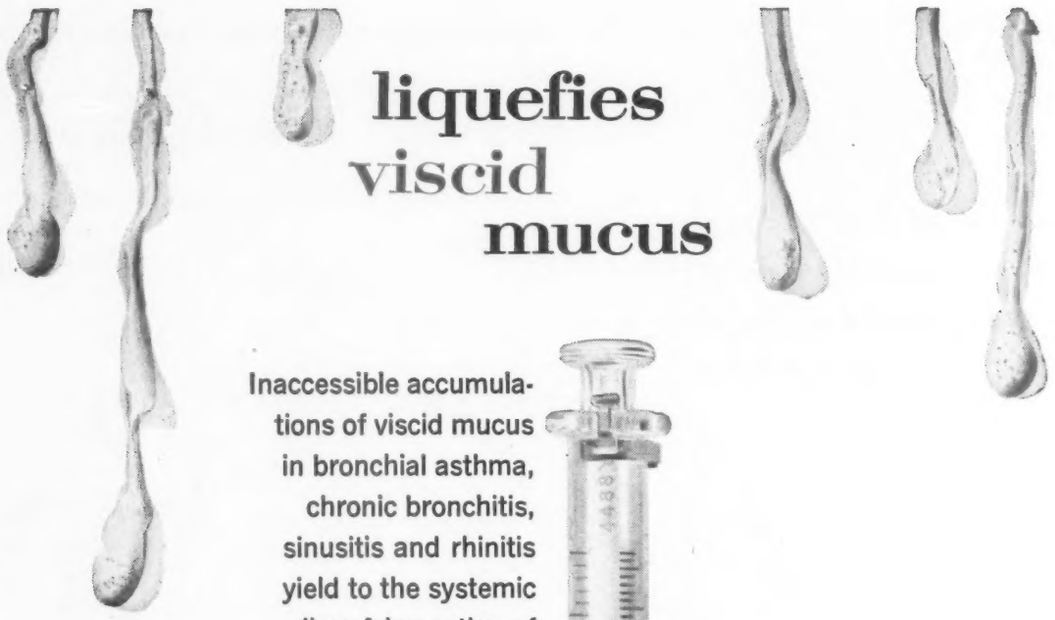

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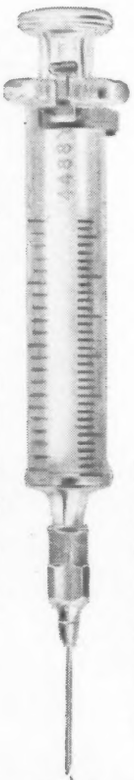

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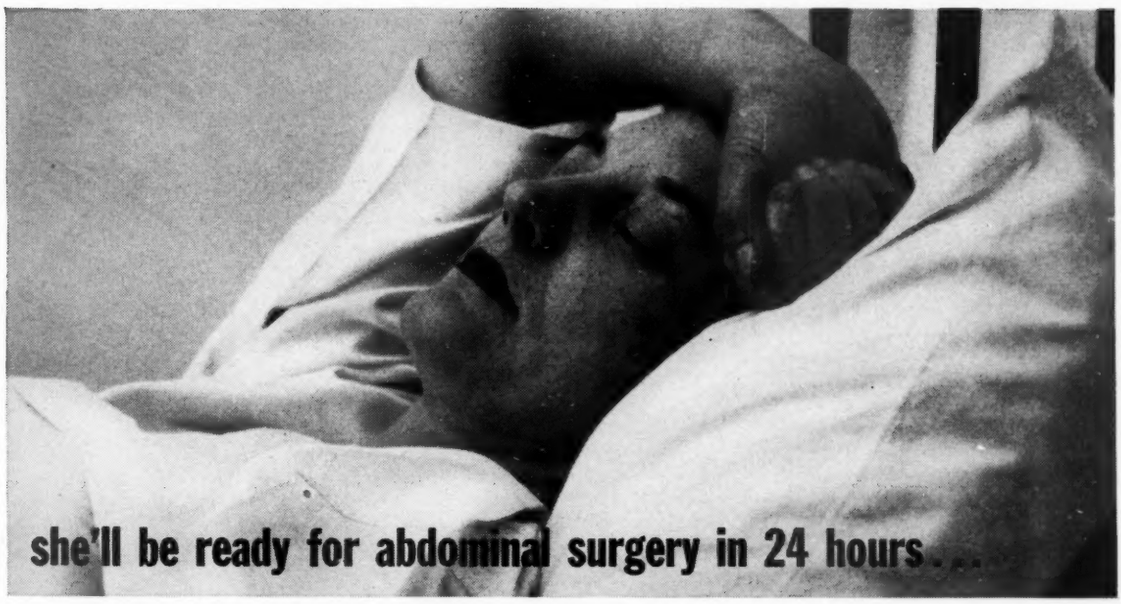

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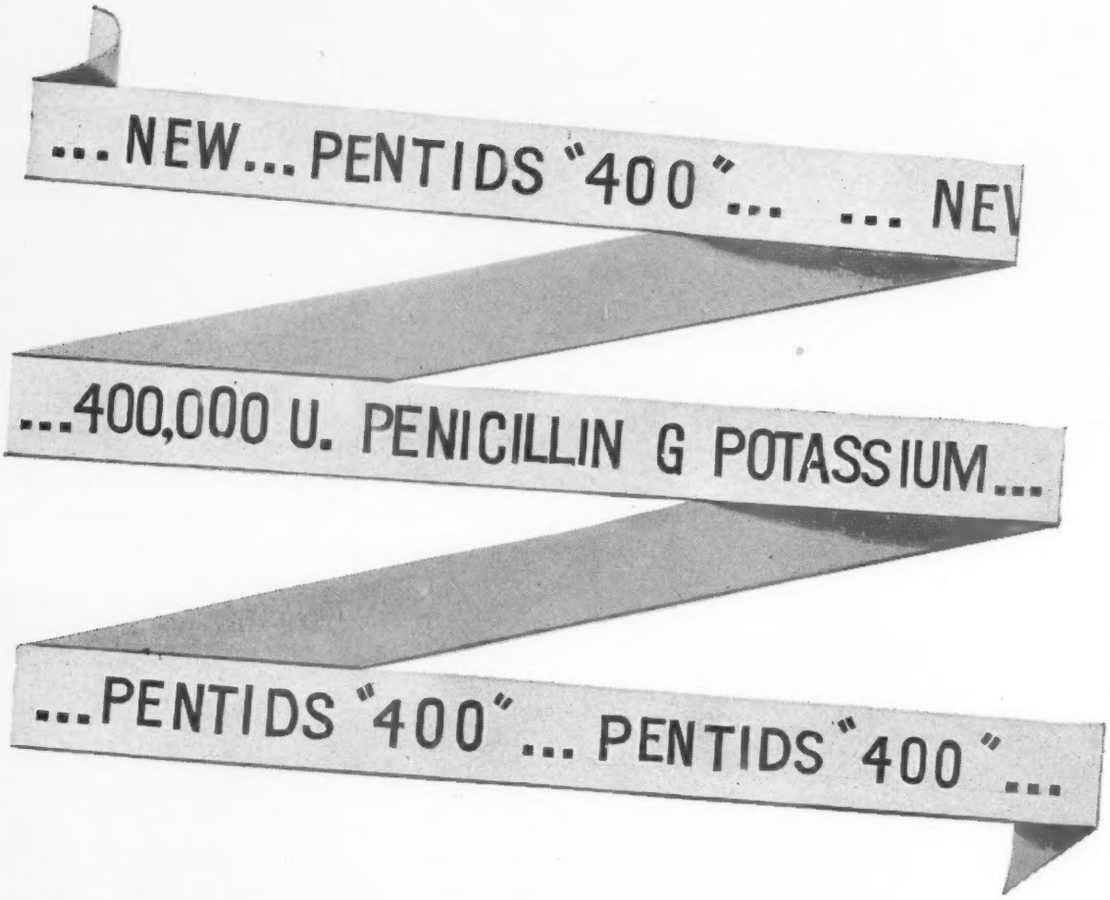

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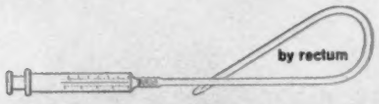

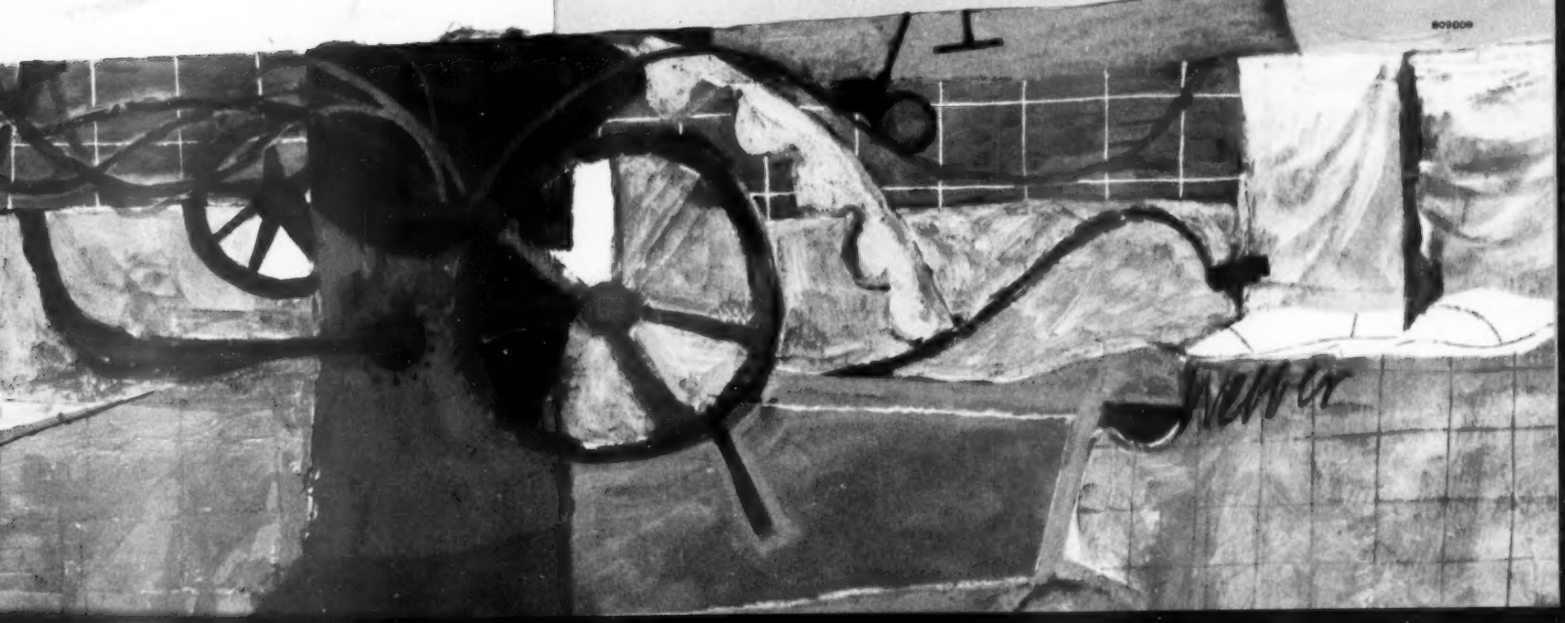

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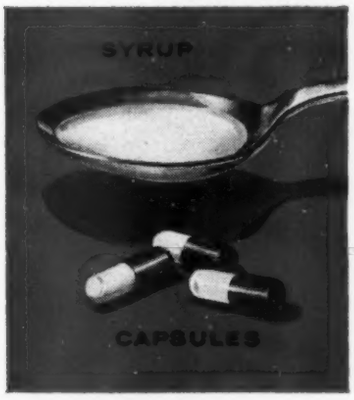

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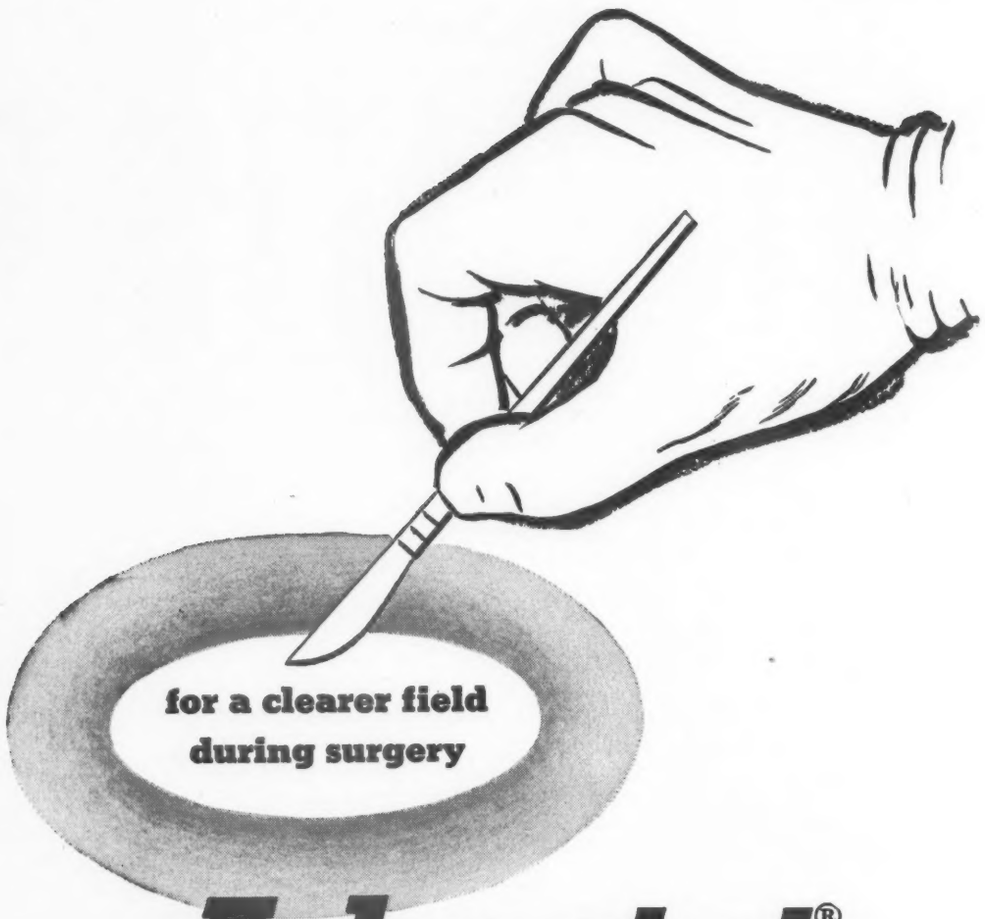

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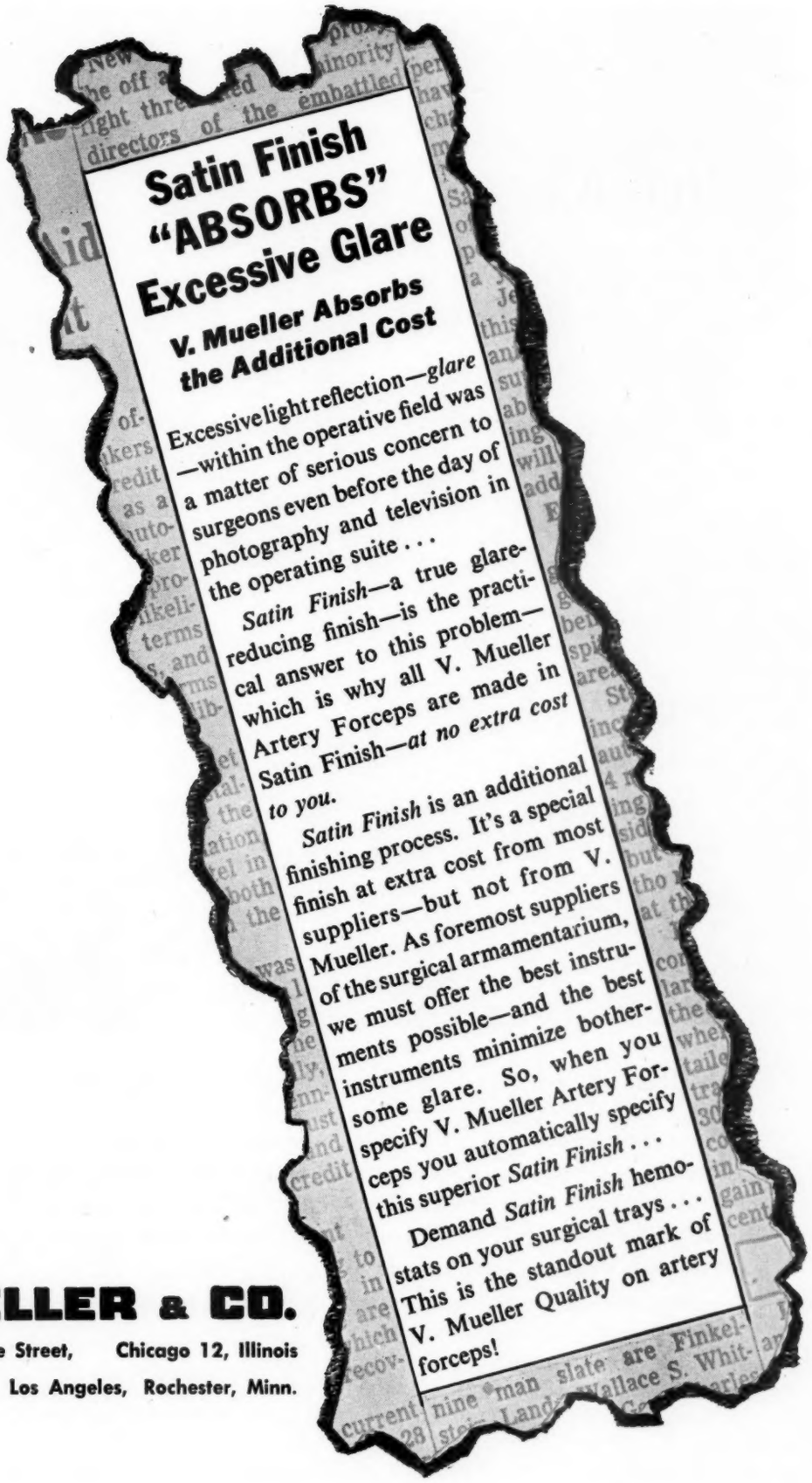

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EDITORIAL

Cardiopulmonary Bypass

ONE of the most ensnaring avenues of endeavor on the surgical frontier is the cardiopulmonary bypass, ensnaring because when one enters the field he becomes entangled with the intricacies of engineering, of constantly improving mechanical and physical equipment, and the trials of organizing and maintaining a team larger than that used for any other surgical procedure. There has been a fantastic increase in the amount of effort spent on heart-lung machinery and its use since 1953 when Gibbon culminated over twenty years of investigative work in the first successful use of a complete cardiopulmonary bypass to repair an intracardiac defect. Since then many models of pumps and oxygenators with almost scores of modifications of each have been tried. Bubbles, rotating screens, stationary screens, rotating discs and membranes have been investigated as a means of oxygenating blood. Rollers, bar compression, air pressure, piston, hydraulic and finger pumps have been used without much clear-cut evidence of the ultimate superiority of one type of pump over another. While the Smithsonian Institute is collecting earlier models of now outdated equipment, one interested company is marketing four different types of pump oxygenators, has sold as many as sixty of one particular type, and can furnish the interested surgeon with a complete set of cannulas, connectors, tubing, instruction books and, in brief, everything required except experience.

In the national rush to the band wagon and because of the urgency of the clinical problem of numbers of patients requiring cardiopulmonary bypass for repair of intracardiac defects, the major effort has been in debugging the available units, and the supply of basic knowledge pertaining to cardiopulmonary bypass and perfusion has woefully lagged behind the applied technology. A high proportion of surviving and apparently cured patients is being obtained by many teams. Since the methods differ so widely it seems unlikely that all of the technics used are correct, but rather that this is another demonstration of the marvelous adaptability of the human organism. Variations as much as three- and fourfold in the volume of blood pumped during the bypass seem tolerated in the hands of different teams, almost all pumping less than the expected cardiac output of the anesthetized patient. Although most groups seem to be working toward a higher flow there is still indecision as to whether one should aim for a high, low or intermediate flow ranging from 40 to 150 ml. per kg. of body weight. Some of this discrepancy is smoothed out if flows are computed on the basis of body surface area, as the highest flows are used in infants and young children with large surface area relative to body weight. In the early experience one objection to high flow, approaching the resting cardiac output, was the recognized damage to blood and the patient by a high rate of handling blood, but it seems probable that given adequate equipment one should aim for a flow comparable to that of the resting anesthetized individual. The experimental evidence for this is not yet conclusive.

Equally puzzling is the fact that most of the equipment in use supplies a relatively nonpulsatile flow to the organism. There is evidence that the earlier work showing the unimportance of a pulse in maintaining proper flow throughout the body needs to be re-examined with a

finer focus and with the use of more refined equipment and technics. The bulk of the available evidence tends to show that bubbles and the antifoam that is used to disperse them are not desirable, but the evidence is not convincing that one should discard the bubble oxygenator which has done so much to make open heart surgery widely available. In fact, some of the best results in the country are with the use of this equipment.

In spite of this demonstration of what can be tolerated with the cardiopulmonary bypass all is not entirely well. Some degree of postoperative acidosis is usually found, when looked for, and there are occasional unexplained deaths which may be related to the perfusion if for no other reason than they are becoming less frequent with greater experience and improvement in technic.

Along with improvement in equipment and its use, the limits of operability of patients are being widened. The principal limiting factor currently in patients with correctible cardiac defects is the presence of changes in the pulmonary vascular bed associated with an increase in resistance. In these, better care is yielding a growing percentage of successes. Some precarious patients have been carried through the stressful postoperative period with care beyond anything conceived of five years ago, including the use of tracheotomy and a respirator to maintain ventilation and, in the presence of heart block, electrical stimulation of the heart to maintain cardiac output until the heart has time to recover from the operative insult.

Problems associated with the use of the pump oxygenator are legion in the eyes of one who has not slowly acquired the knowledge of its intricacies. This will continue to be true as equipment and technics are simplified. In the meantime, for those who will spend the effort and absorb a moderate amount of grief, there is no more satisfying, rewarding or pioneering field than that of open heart surgery with the cardiopulmonary bypass. It offers a gold mine for the investigator laboring to bring the science of the physiology of perfusion abreast of the technology of its machinery.

HENRY T. BAHNSON, M.D.,
The Johns Hopkins University and Hospital,
Baltimore, Maryland

SCIENTIFIC PAPERS

Giant Cell Tumor of Bone

BRADLEY L. COLEY, M.D., *New York, New York,* NORMAN L. HIGINBOTHAM, M.D., *New York, New York,* AND TATSUMI KOGURE, M.D., *Tokyo, Japan*

From the Bone Tumor Department, Memorial Center for Cancer and Allied Diseases, New York, New York.

THE term giant cell tumor refers to a specific type of primary bone tumor whose clinical, roentgenographic and histologic features are so characteristic as to be generally recognized and accepted as an entity.

In 1938 Coley and Higinbotham reported a series of 124 cases of giant cell tumor observed in the Bone Tumor Department of Memorial Hospital and in the Hospital for Special Surgery. In the intervening twenty years there have been many communications on this subject both in American and European literature. Judging from the wide difference of opinion expressed by the authors of these papers one is forced to conclude that there still exist many controversial features of this disease.

Among the issues which remain unsettled are the clinical implications to be derived from a study of the histology of these tumors. The most acceptable method of treatment is still a matter of debate and considerable disagreement exists among authorities in the fields of surgery and of therapeutic radiology. There is still some uncertainty in the interpretation of microscopic findings in cases of giant cell tumor and the clinical course cannot always be predicted on the basis of histologic criteria obtained early in the course of the disease.

Since our previous communication a number of cases have been eliminated because of change in histologic diagnosis. Some cases previously classified as giant cell tumor have been excluded since they are now recognized as aneurysmal bone cyst or benign chondroblastoma; sixty-four additional cases of giant cell tumor have been included and this communication deals only with cases observed on the Bone Tumor Service of Memorial Hospital. The present series represents 108 cases, all of which have been microscopically confirmed as giant cell tumor.

HISTORY

Giant cell tumor was originally recognized in 1818 by Sir Astley Cooper [*13*]. Lebert [*28*] in 1845 first pointed out its benign nature, and Paget [*34*] gave an accurate description of it in 1853 in his classic contribution. Nélaton [*33*] in 1860 described the clinical and microscopic features of the lesion and asserted that the process was only locally malignant. Two years later Virchow [*40*] showed that it might recur and even prove malignant, and he referred to the "degeneration into cancer" which has been mentioned by authors since the days of Paré and Fernel.

Gross [*22*], in 1879, in a detailed analysis of some seventy cases, recognized the difficulties encountered in attempting to distinguish the lesion from malignant medullary sarcoma but he insisted on its benign nature.

Despite this diversity of opinion the lesion was commonly referred to as giant cell sarcoma and accorded the treatment consistent with such interpretation, i.e., amputation. However, this was before the advent of roentgenographic diagnosis which made accurate identification of this tumor much easier.

In 1923 Bloodgood [*2*] strongly advocated conservative treatment and warned against needless amputation; he insisted on replacing

the term giant cell sarcoma with that of benign giant cell tumor.

William B. Coley [*10*] took issue with Bloodgood as well as with those pathologists who assumed that giant cell tumors of the long bones were always benign and never gave rise to metastases, and in his publication of 1927 he stated: "The great majority of cases are benign or at least only locally malignant but the lesion should still be classed as a sarcoma since in certain cases it has all the clinical features of a malignant bone tumor causing death by metastasis." In 1935 he reported that nearly 15 per cent of the giant cell tumors coming under his observation had become malignant.

TABLE 1
FIVE-YEAR RESULTS IN GIANT CELL TUMOR OF BONE

	No. of Cases	
Clinical diagnosis	142	
Without histologic verification	34	
With histologic verification	108	
I. Indeterminate group		36
A. Dead of other causes in less than 5 yr., without recurrence		1
B. Lost to follow-up, without recurrence		1
C. Less than 5 yr. follow-up, without active evidence of disease		34
II. Determinate group (available for 5 yr. statistical survey)		72
A. Failures (19 cases):		
1. Dead of disease		10
2. Lost to follow-up, with disease		4
3. Dead of other causes but with disease		5
4. Postoperative deaths		0
B. Successes (53 cases):		
1. Free of disease 5 or more yr. after treatment		53 (73.6%)

In 1940 Jaffe and his co-workers [*25*] made an effort to clarify the situation by suggesting a basis for the histological classification of these tumors. He designated three grades. Grade I contains the least aggressive tumors, in which the stromal cells although abundant, are not compacted and do not exhibit any appreciable atypism. Grade II is manifest cytologically by a very compact cellular stroma showing definite evidence of atypism. Such cases have a strong tendency to recur and sometimes eventually to undergo malignant transformation. Grade III represents the small group which present a sarcomatous type of stroma and are already frankly malignant. Such cases frequently metastasize regardless of how they are treated.

In 1955 Thomson and Turner-Warwick [*39*] indicated that they placed some reliance on the grading of these tumors as a guide to prognosis. They offered the following explanation: "The Grade I tumors may recur locally, but have not metastasized. The Grade II tumors are likely to recur locally and may metastasize; the metastasizing examples of this grade cannot be differentiated histologically and the microscopic appearance of the secondary deposits is identical to those of the primary tumor. The Grade III tumors behave as frank sarcomata and, unless early and radical treatment is instituted, metastases inevitably occur."

In 1954 Williams, Dahlin and Ghormley [*41*] analyzed a group of 101 cases of giant cell tumor treated at Mayo Clinic. They found that 10 per cent of them, although originally regarded as benign, later underwent malignant transformation and required amputation. These authors agree with Willis [*42*], Russell [*35*] and others that potentially aggressive or malignant giant cell tumors are not distinguishable as such histologically at the outset.

It is our opinion that while reliance can be placed on a histologic report of grade III tumors, the difficulty arises when cases of grade II are encountered. Many of these in our series were originally considered as belonging in grade I but, following surgical or radiation therapy, underwent a change to grade II and some underwent further transformation to grade III. Some of the grade II cases terminated fatally and in others amputation was required to control the disease.

We agree unqualifiedly with those who maintain that it is not possible to predict the ultimate outcome of a case from a study of the initial histology of the tumor. Some giant cell tumors, benign at the start, will remain so while others progress, often by insensible gradations, from grade I to grade III and terminate fatally with pulmonary metastasis.

It has become increasingly apparent that cases which were formerly included as giant cell

tumor are now being classified as aneurysmal bone cyst. To a lesser extent occasional cases which were considered as giant cell tumor are now designated as benign chondroblastoma although thirty years ago Codman [6] used the term epiphyseal chondromatous giant cell tumor to describe them. Unquestionably cases of solitary bone cyst, non-osteogenic fibroma and even monostotic fibrous dysplasia may in the past have been regarded as giant cell tumor and thus were included in some of the earlier reports.

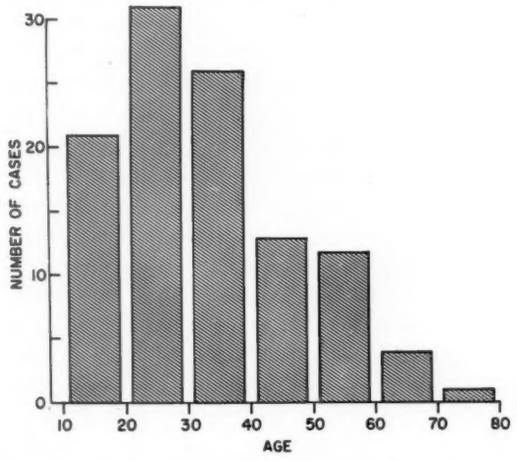

FIG. 1. Age incidence of patients with giant cell tumor.

After excluding twenty-five cases which lacked microscopic confirmation and nine others in which the diagnosis has been changed (five to osteogenic sarcoma, three to aneurysmal bone cyst and one to benign chondroblastoma) there remain 108 authenticated cases of giant cell tumor observed at Memorial Hospital between 1915 and 1957, a period of forty-two years. (Table 1.)

STATISTICAL DATA

Age Incidence. Nearly 50 per cent of our patients were in the third and fourth decades of life (twenty to forty). (Fig. 1.) The youngest patient was eleven years old, and the oldest seventy-one.

Sex. In this series there were forty-five males and sixty-three females. Most statistical surveys show this slight predominance in the female.

Location. Most authorities believe that this tumor originates in the epiphyseal region from which it may, in advanced cases, extend to the adjacent metaphysis and even to the diaphysis. According to Willis [42] the tumor develops in the metaphysis and later invades the epiphysis. This tumor shows a predilection for the epiphysis particularly of the lower end of the femur, upper end of the tibia, the lower end of the radius and the pelvis. (Fig. 2.)

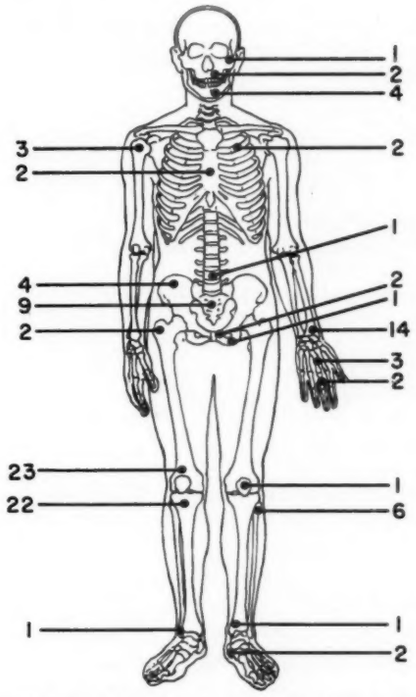

FIG. 2. Distribution of 108 cases of giant cell tumor.

CLINICAL FINDINGS

Symptoms. Pain is the most prominent initial complaint and was noted in 88 per cent of our cases. At the onset it may be mild and often intermittent. It is usually aggravated by activity and partially relieved by rest. Swelling was observed in more than half of our cases. Both pain and swelling were complained of in 48 per cent of our patients and in 20 per cent there was disability referable to the adjacent joint.

Pathologic fracture was noted as the presenting symptom in nine cases.

While there was a history of trauma localized to the area of the tumor in 36 per cent, its importance as an etiologic factor is still unsettled.

Physical Examination. The objective findings in giant cell tumor may be minimal. Swelling, tenderness and limitation of motion of the adjacent articulation may be present. In about 10 per cent of cases increased local surface temperature was observed which may be attributed to underlying increased vascularity. Limitation

of normal range of motion occurred in 25 per cent of cases.

Roentgenographic Appearance. This tumor generally presents a rather characteristic roentgenographic appearance and radiologists are able to make a correct diagnosis in a higher per-

TABLE II
FIVE-YEAR SURVIVAL RATE OF FIFTEEN PATIENTS WITH MALIGNANT GIANT CELL TUMOR

Results	No. of Patients
Indeterminate group:	
Dead of other causes in less than 5 yr., without recurrence	0
Lost to follow-up, without recurrence	1
Determinate group:	
Failures	
Dead of disease	9
Lost to follow-up, with disease	0
Dead of other causes but with disease	0
Postoperative deaths	0
Successes	
Free of disease 5 or more yr. after treatment	5 (35.7%)

centage of giant cell tumors than in most other types of bone neoplasms. Nevertheless other lesions may simulate this tumor so closely as to make a correct radiographic interpretation extremely difficult. Among them are aneurysmal bone cyst, central chondroma and chondromyxoid fibroma, benign chondroblastoma, central medullary fibrosarcoma, secondary chondrosarcoma and solitary plasma cell myeloma.

The x-ray findings usually show a circumscribed osteolytic area occurring in the epiphyseal region of a long bone. It may involve the adjacent metaphyseal region but seldom extends far into the diaphysis.

Trabeculations may sometimes be seen producing a compartmental appearance like the cut surface on an onion or like soap bubbles.

In rapidly growing tumors erosion of the overlying cortex may be so complete as to leave no visible bony shell.

Blood Chemistry Findings. Serum calcium, phosphorous and alkaline phosphatase determinations are usually found to be normal unless the patient has other complications. If a pathologic fracture has occurred, the serum alkaline phosphatase is often slightly elevated; and if malignant degeneration has developed or the tumor was malignant from the start, the phosphatase value may be elevated.

Diagnosis. While the history and physical examination are important features, emphasis should be placed upon the roentgenographic findings of the involved area because these will point to a correct diagnosis in a high proportion of cases. Nevertheless it is important to obtain histologic confirmation of the diagnosis and for this purpose aspiration biopsy has, in our hands, proved a valuable adjunct. We are opposed to beginning treatment before the diagnosis has been firmly established, and in the series under discussion 50 per cent of the cases had accurate histologic confirmation by means of aspiration biopsy prior to treatment.

Open biopsy for giant cell tumor should seldom be done as a single step; instead the entire area should be curetted and the walls of the cavity cauterized with zinc chloride. Bank bone chips may then be used to fill the defect. This not only furnishes the pathologist with all of the diseased tissue from which a more accurate diagnosis may be made but also it may well constitute a combination of biopsy and definitive treatment. We have seen some disastrous results following open biopsy in giant cell tumor. Marked bleeding has occasionally impelled the surgeon to pack the wound in order to control the ensuing hemorrhage; thereafter infection and fungation of the tumor have greatly complicated future management.

MALIGNANT GIANT CELL TUMOR

Of the fifteen cases of malignant giant cell tumor observed in this series, four were diagnosed as malignant from the outset and eleven as a result of subsequent transformation from benign to malignant.

In the group in which the histologic diagnosis was malignant giant cell tumor from the start, one patient was seen but once and then lost to follow-up; one died of pulmonary metastasis in three and a half years; two are alive and well twenty-seven and eight years after treatment by surgery, respectively.

Eight of the eleven patients with malignant transformation of giant cell tumor died, five of them with pulmonary metastasis. One patient died of extensive local recurrence and pulmonary embolism, and in another the cause of death was unknown. Of the three five-year survivals, one died in fourteen years and one in six years, in each instance the cause being

TABLE III
MALIGNANT GIANT CELL TUMOR

Case No. and Patient's Initials	Age and Sex	Location of Lesion	Initial Histologic Diagnosis	Final Diagnosis	Interval between Diagnoses	Treatment	Metastases	Result
1, H. A.	47, F	Patella	Malignant giant cell tumor	Malignant giant cell tumor	.....	Patellectomy	Pulmonary; lumbar vertebrae	Died in 3 yr. 6 mo. of metastases
2, H. C.	27, M	Distal femur	Giant cell tumor	Malignant giant cell tumor	11 mo.	Radiation; curettage; amputation	Pulmonary and local after amputation	Died in 2 yr. 2 mo. of metastases
3, J. C.	25, M	Sacrum, 5th lumbar vertebra	Unknown	Malignant giant cell tumor	.....	Surgical removal 5 yr. previously; radiation 4 yr. previously	.....	Died in 5 yr. of extensive local recurrence, pulmonary edema and embolus
4, M. H.	37, F	Ilium	Malignant giant cell tumor	Malignant giant cell tumor	.....	Curettage and bone graft	.....	Well and alive for 8 yr.
5, H. L.	19, M	Metacarpal	Malignant giant cell tumor	Malignant giant cell tumor	.....	Resection previous to admission	.....	Lost to follow-up after first visit
6, C. M.	35, M	Ilium	Giant cell tumor	Malignant giant cell tumor	3½ yr.	Curettage and bone graft; hemipelvectomy	.....	Well and alive for 2 yr. since hemipelvectomy
7, H. L. N.	18, M	Proximal fibula	Atypical osteogenic sarcoma	Malignant giant cell tumor	.....	Amputation	.....	Well and alive for 27 yr.
8, W. H.	47, M	Sacrum, ilium	Giant cell tumor	Malignant giant cell tumor	5 yr.	Repeated radiation	.....	Died in 6 yr.; cause undetermined
9, F. S.	28, F	Proximal tibia	Giant cell tumor	Malignant giant cell tumor	2½ yr.	Curettage and cauterization; amputation	.....	Died in 14 yr.; cause undetermined
10, P. S.	63, F	Ischium, pubic bone	Giant cell tumor	Malignant giant cell tumor	3 yr.	Radiation; hemipelvectomy	.....	Well and alive for 5 yr. since hemipelvectomy
11, E. S.	32, M	Proximal tibia	Giant cell tumor	Malignant giant cell tumor	3 yr.	Curettage and bone graft; hemipelvectomy	Pulmonary	Alive with metastases for 10 mo. since amputation
12, L. S.	35, M	Distal femur	Malignant giant cell tumor	Malignant giant cell tumor	.....	Curettage and cauterization; amputation	Pulmonary; thoracic vertebra	Died in 6 mo. of metastases
13, M. L.	44, M	Proximal tibia	Giant cell tumor	Malignant giant cell tumor	5 yr.	Curettage; curettage and cauterization for recurrence; amputation; x-ray for recurrence; amputation of stump	Pulmonary; local (amputated stump)	Died in 5 mo. of metastases
14, G. G.	39, M	Distal femur	Giant cell tumor	Malignant giant cell tumor	2 yr.	Curettage and x-ray concurrently; amputation	Pulmonary; groin	Died in 4 yr. of metastases
15, J. N.	19, M	Proximal tibia	Giant cell tumor	Malignant giant cell tumor	1 yr.	Curettage; radiation; amputation	Pulmonary	Died in 2 yr. of metastases

unknown; the third patient is alive and free of disease five years since hemipelvectomy. (Table II.)

The longest interval in the transformation from benign to malignant was five years and the shortest was two months.

TABLE IV
PATIENTS FOLLOWED UP TWENTY YEARS OR MORE

Treatment	No. of Cases
Radiation initially (7 by x-ray and 3 by radium)	10
Good result	4
Poor result	6
Surgery initially	6
Good result	2
Fair result	2
Poor result	2
Total	16

Amputation was performed in ten cases as soon as the malignant nature of the lesion was established; two of these required hemipelvectomy. Total excision of the patella was performed in one case.

Of the ten patients who underwent amputation, three are alive without evidence of disease for twenty-seven years, five years and two years, respectively. Five patients died of pulmonary metastases and in another the cause of death is unknown. One patient is living with metastases ten months after treatment. (Table III.)

Treatment. Undoubtedly the trend away from initial radical surgery toward more conservative measures was stimulated by Bloodgood's repeated insistence that the term giant cell sarcoma should be replaced by benign giant cell tumor. Curettage became the accepted method of treatment. Radiation therapy then received gradually increasing attention and Ewing [*19*] and others emphasized its advantages. Thus for the past two decades these have remained the most widely accepted forms of therapy.

It has become increasingly well recognized, particularly in recent years, that neither of these methods of treatment has yielded uniformly satisfactory results. Recently a number of authorities have emphasized the fact that regardless of whether a case of giant cell tumor is treated by curettage or by radiation there is a definite possibility that healing will not take place and that persistence of the disease will require further treatment. Moreover a substantial percentage of cases will show a change

TABLE V
CASES FOLLOWED UP TEN TO TWENTY YEARS

Treatment	No. of Cases
Radiation initially	10
Good result	5
Fair result	2
Poor result	3
Curettage and cauterization with or without bone graft	8
Good result	3
Fair result	1
Poor result	4
Resection (head of fibula) with local recurrence after 2 yr.; second resection yielded good result	1
Total	19

in the microscopic appearance from what is clearly a benign structure to one that is obviously sarcomatous. This transition may frequently be by comparatively insensible gradations.

At present, then, the two schools of thought have many adherents; for the most part the surgeons favor curettage or resection and the radiologists subscribe to radiation. In view of the unpredictable behavior of this neoplasm it is not surprising that there is this difference of opinion as regards its treatment.

In the series presented herein, forty-two patients had radiation therapy, fifty-one underwent curettage, with or without bone grafts, seven had a combination of these methods, and eight had initial radical surgery (amputation for the most part).

Of the entire series of 108 cases, seventy-nine had a follow-up of two or more years and are discussed from the standpoint of results obtained. (Tables IV through VII.) We have considered the results on the basis of control of the primary growth without loss of limb, and also of salvage of the patient when local control failed and amputation became necessary. The problem of estimating end results is admittedly

a difficult one when basing such results purely upon statistics.

Of the ten patients treated by radiation initially four eventually required amputation (one for postoperative radiation sarcoma and three for failure to control the disease locally). In two other cases there were complications of radiation treatment (radiation ulceration and ankylosis of adjacent joint).

Of the six patients treated initially by surgery, one underwent amputation at the outset because of a histologic diagnosis of osteogenic sarcoma which on recent review by the pathologist was changed to malignant giant cell tumor. In another case amputation was required following treatment by curettage and radiation therapy. Two patients were treated by local surgery alone with complete control of the disease.

Of the ten patients treated initially by radiation, recurrence requiring further treatment developed in three.

Of the eight patients treated initially by curettage, recurrence requiring another curettage and bone graft developed in one and two required amputation.

TABLE VI
CASES FOLLOWED-UP FIVE TO TEN YEARS

Treatment	Cases
Radiation initially	7
Good result	2
Fair result	3
Poor result	2
After recurrence hemipelvectomy was required in one case	
Death (6 yr. later) from malignant transformation in 1 case	
Curettage and cauterization with or without bone graft	10
Good result	6
Poor result	4
These four cases recurred and were treated by resection in one case, and repeated curettage in three cases with good results	
Resection and bone transplant for recurrent lesion of distal radius; resection failed; radiation proved successful	1
Resection of head of fibula, with good result	1
Excision of portion of head of tibia, with good result	1
Curettage and x-ray therapy combined	2
Recurrence in both; 1 underwent amputation and the other died in 5 yr. of extensive local recurrence	
Total	22

CASE REPORTS

The following six cases are illustrative of some of the points brought out in the text:

TABLE VII
CASES FOLLOWED UP TWO TO FIVE YEARS

Treatment	No. of Cases
Radiation	7
Good result	4
Fair result	1
Poor result	2
Recurrence after 4 yr. in 1 patient who refused to return for further treatment	
One patient died after 4 yr.; cause of death unknown	
Curettage and cauterization with or without bone graft	9
Good result	2
Poor result	7
All 7 patients recurrence; 5 had second curettage with good results	
Case malignant from start; patellectomy performed; patient died in 3 yr. of pulmonary metastases	1
Rib resection, with good result	1
Curettage and postoperative radiation	3
Sacral case treated elsewhere by biopsy and wound packing plus radiation; patient died	1
Total	22

CASE 1. C. M., a thirty-five year old man, was admitted to Memorial Hospital with the chief complaint of pain in the region of the left hip. His difficulties had begun approximately four years previously. In November, 1951, x-ray examination showed a bone tumor of the left hip (Fig. 3); this was biopsied at another hospital. Following the report of giant cell tumor, curettage and bone graft was performed. Six months later a recurrence was noted, and x-ray therapy was administered. Approximately two years prior to admission to Memorial Hospital the patient sustained a pathological fracture of the left hip which was treated by a plaster hip spica. For eighteen months the left hip was painful, fixed in a position of flexion with almost complete limitation of motion. He was then admitted to Memorial Hospital on April 27, 1955. X-ray films of the left hip and pelvis showed a recurrent tumor of the head and neck of the femur also involving the innominate bone. (Fig. 4.) The original pathological sections were reviewed

3 4 5

FIG. 3. Case I. Appearance before treatment of giant cell tumor of upper end of femur. The lesion was curetted and bone chips were used, but recurrence took place and x-ray therapy was given without improvement.

FIG. 4. Case I. Same case three years later showing condition on admission to Memorial Hospital. The disease has destroyed the head, neck and part of the shaft of the femur and crossed the joint to invade the acetabulum. At this time hemipelvectomy was performed.

FIG. 5. Case I. Same case showing appearance following hemipelvectomy. Patient well and free of disease two years after operation.

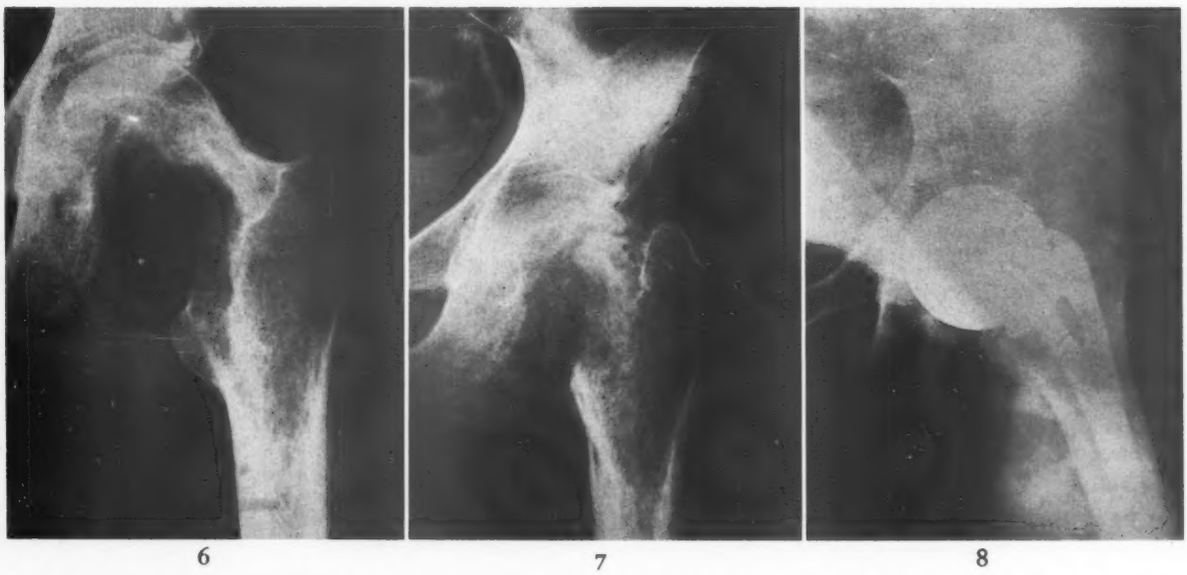

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FIG. 6. Case II. Appearance on admission to Memorial Hospital following previous curettage, bone graft and subsequent x-ray therapy elsewhere. Microscopic diagnosis was giant cell tumor.

FIG. 7. Case II. Shows condition four months later after pathologic fracture and failure of further radiation to control the disease.

FIG. 8. Case II. Appearance following resection and insertion of prosthesis. Patient has excellent functional result and no evidence of recurrence sixteen months later. Microscopic diagnosis still giant cell tumor.

by Dr. Fred Stewart who rendered the following report: "Giant cell tumor; mostly classical; one slide has an area with nuclei reduced and stromal elements very numerous; here it appears aggressive." X-ray of the chest was normal. The complete picture was reviewed and a decision was reached that hemipelvectomy was indicated; it was performed on May 5, 1955. The report on the specimen was "malignant giant cell tumor." The patient was discharged from the hospital on May 27, 1955,

FIG. 9. Case III. Giant cell tumor of medial femoral condyle in a fifty year old man. Appearance when first seen.

FIG. 10. Case III. Same case six months later after recurrence following curettage and implantation of bone chips. Note the extent of the disease.

with a well healed wound. He was seen in our clinic recently and is in good health two years after hemipelvectomy, working as clerk in a ticket office. (Fig. 5.) He uses a prosthesis effectively.

CASE II. W. M., a twenty-three year old white man, was in apparent good health until June, 1954, at which time he began to experience pain in the left hip which became steadily more severe and was aggravated by motion. He consulted a physician who prescribed symptomatic treatment but no x-ray films were taken until September, 1954. At this time he was hospitalized in another city where an open biopsy was performed on the basis of a suspicious lesion in the neck of the left femur revealed by x-ray. A diagnosis of giant cell tumor was established microscopically and in November, 1954, the patient was again operated upon, the tumor curetted and bone chips placed in the cavity. The postoperative course was uncomplicated and he was well until two weeks prior to his admission to Memorial Hospital when x-ray films revealed failure to control the lesion. (Fig. 6.) It was believed that x-ray therapy should be tried since complete extirpation of this tumor in this location might have necessitated hemipelvectomy. Accordingly the patient was treated using 250 kv. through two portals to the neck of the left femur, and was given a tumor dose of 2,250 r. In spite of precautions the patient sustained a pathologic fracture of the neck of the left femur on December 12, 1955. (Fig. 7.) Thereupon it was decided to resect the left femoral head and neck and insert a Vitallium® prosthesis. (Fig. 8.) This was done on February 23, 1956, and an Austin Moore type prosthesis was used. He was discharged on crutches six weeks after operation and followed thereafter as an outpatient. He was last seen on May 22, 1957, at which time he was walking almost normally and had an excellent range of motion. He had no complaints and had returned to his former occupation.

The final pathologic diagnosis was giant cell tumor with moderate atypia.

CASE III. C. K., a fifty year old man, stated that he had fallen on June 5, 1956, and since that time had had pain and swelling of the left knee. On admission, positive physical findings were limitation of motion of left knee and tenderness to deep palpation on the medial aspect of the knee corresponding to a point where x-ray films revealed a lytic lesion in the medial condyle. (Fig. 9.) On July 2, 1956, curettage of the lesion was carried out and bank bone chips implanted. The postoperative course was uneventful and he was discharged from the hospital in a long leg cast two weeks after admission. However, follow-up x-ray examination

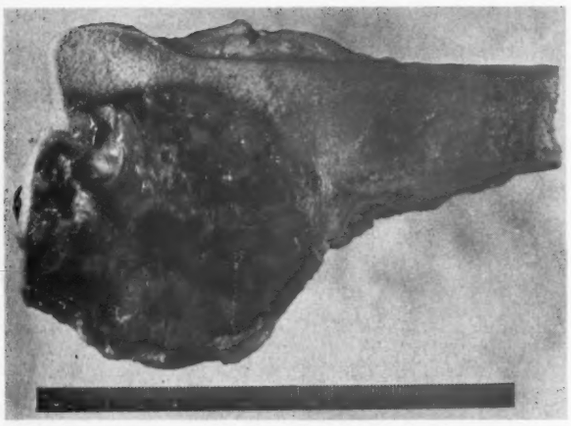

FIG. 11. Case III. Specimen obtained at autopsy five months later. Death was due to late pulmonary embolism. Note complete failure of curettage to control the tumor which extends for a considerable distance into the diaphysis.

five months later showed increasing bone resorption without repair and with evidence of recurrent tumor. (Fig. 10.) Aspiration biopsy on December 19, 1956, showed recurrent giant cell tumor. At this time, on review of the x-rays by the Radiation Therapy Department, it was thought that further conservative surgery was not likely to be successful and that x-ray therapy offered the best hope for control of the tumor. On December 27, 1956, treatment was begun with the Cobalt unit and he received one treatment. On December 28, 1956, the patient was found on the bathroom floor and died shortly thereafter. A postmortem examination revealed the cause of death as massive pulmonary embolism. A clot extended from the vena cava to the left iliac vein. Autopsy revealed a malignant giant cell tumor. (Fig. 11.)

CASE IV. H. G., a twenty-two year old man, was admitted to Memorial Hospital on May 26, 1931, with a history of occasional pain in the left knee following twisting of the left leg while working seven months prior to admission. X-ray films revealed a lesion in the epiphyseal region with slight evidence of trabeculation throughout its central portion. The tumor extended posteriorly in an eccentric, blown-out manner. (Fig. 12.) The lesion was diagnosed as giant cell tumor, and promptly curetted and cauterized with zinc chloride. After microscopic examination it was reported as a benign giant cell tumor.

The patient was discharged from the hospital one month later with satisfactory wound healing. He had a smooth postoperative course. X-ray films made two years later revealed complete filling in of the cavity with new bone, and the lesion appeared well healed. Microscopic sections were reviewed February 23, 1956, and the tumor was reclassified as aneurysmal bone cyst. (Fig. 13.)

Comment: This is an example of a diagnosis of giant cell tumor revised on review to that of aneurysmal bone cyst.

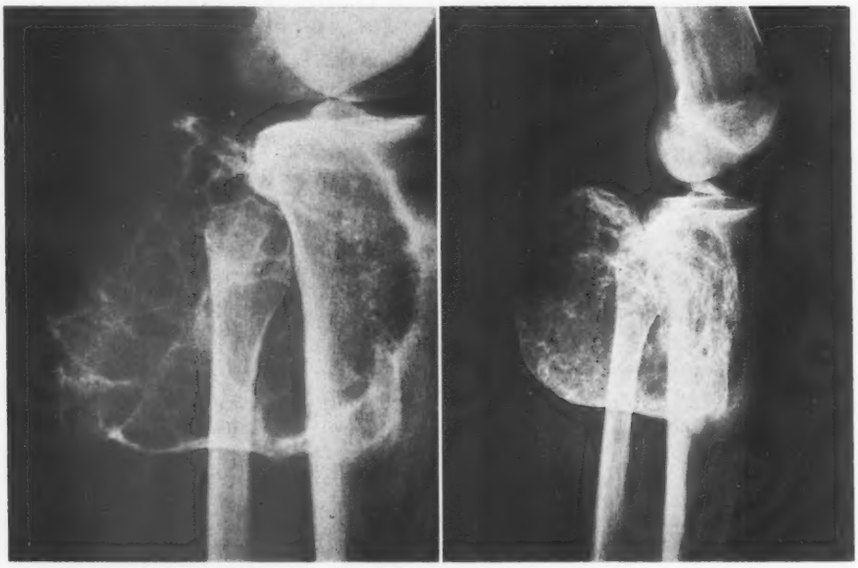

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FIG. 12. Case IV. Aneurysmal bone cyst of tibia. Note eccentric location and "blown-out" appearance. Treatment by curettage. Diagnosis of giant cell tumor originally; changed later to aneurysmal bone cyst.

FIG. 13. Case IV. Same case four years later. Patient followed up twenty-four years with no further symptoms.

CASE V. P. M., a thirty-five year old man, was admitted to Memorial Hospital on May 15, 1944, with a history of an injury to the medial aspect of the left lower thigh two years prior to admission which apparently caused ecchymosis and soft part soreness. He continued to have mild dull ache over this area for slightly more than a year. Films taken on admission show a well circumscribed area of polycystic bone destruction involving the medial condyle of the left femur which the roentgenologist suggested was a giant cell tumor. Observation was carried out for six months because repeated aspiration biopsies failed to establish a microscopic diagnosis.

On November 15, 1945, a curettage and bone graft was done on the assumption that the lesion was a giant cell tumor. The pathologist reported it as "chondromatous giant cell tumor." (Fig. 14.) Convalescence was uneventful and the patient has been symptom-free for the past eleven years.

FIG. 14. Case v. Benign chondroblastoma (Codman's tumor) sometimes mistaken roentgenographically for giant cell tumor.

Comment: X-ray appearance was that of a giant cell tumor. The pathologic diagnosis was chondroblastoma, formerly known as epiphyseal chondromatous giant cell tumor (Codman).

CASE VI. W. D., a thirty year old white man, was first admitted on December 19, 1930, because of development of a benign giant cell tumor in the head of the left fibula following an injury six months earlier. (Fig. 15.) He received about 2,500 r tumor dose to this area in seven and a half months with reduction in the size of the tumor during 1930 and 1931. (Fig. 16.) He was followed up in the clinic until 1933 but was lost track of until 1951

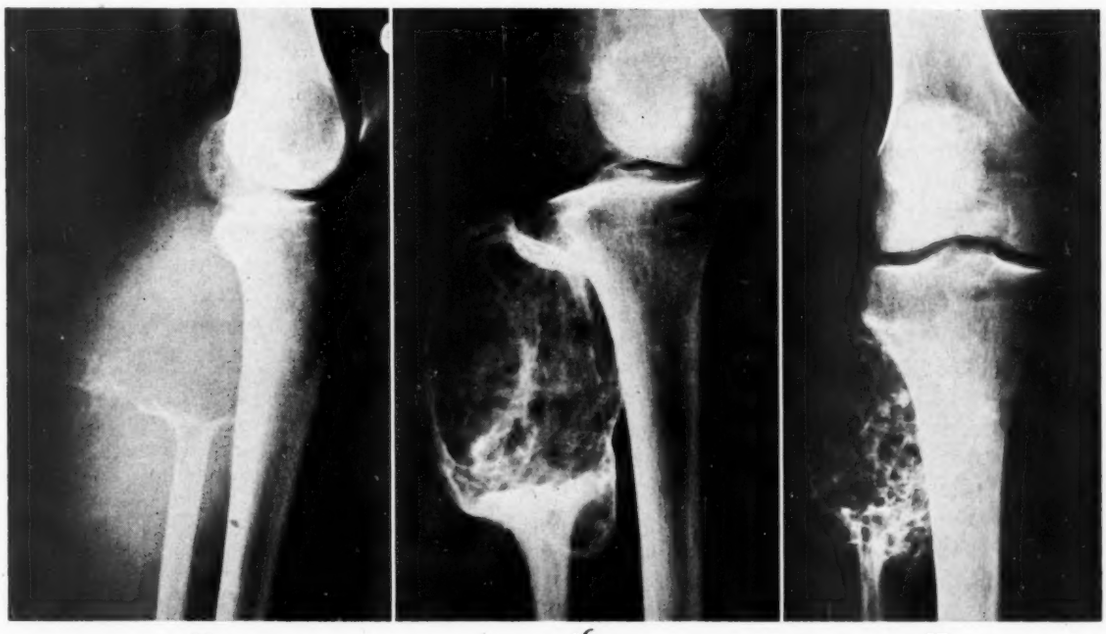

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FIG. 15. Case III. Giant cell tumor of fibula, showing appearance on admission.

FIG. 16. Case III. Same case showing control following x-ray therapy.

FIG. 17. Case VI. Same case twenty-one years after treatment. No symptoms in the interval until shortly prior to this roentgenogram. Pain, swelling and disability developed and biopsy disclosed sarcoma. Amputation was performed. Final diagnosis, postradiation osteogenic sarcoma. Patient alive and well six and a half years postamputation.

when pain developed in the left knee after he stepped in a hole while working. He was seen in the clinic on February 21, 1951, and an x-ray film of the left knee disclosed a diffuse mass 10 by 15 by 10 cm. in the upper third of the left fibula which on aspiration biopsy proved to be postradiation osteogenic sarcoma. (Fig. 17.) A high thigh amputation was performed on February 28, 1951, and the pathologic report was "post-irradiation osteogenic sarcoma, spindle cell, non-bone-forming: associated severe roentgen damage to tendon, fascia and muscle." The patient recovered from the amputation uneventfully and has remained well for six and a half years.

CONCLUSIONS

Giant cell tumor is a primary bone neoplasm which may remain benign and yield to local surgical measures or to radiation. On the other hand, it may recur after treatment with either of these methods or a combination of them. When it recurs it may present the same microscopic appearance as it did when first treated or it may show "aggressive" or "borderline" features. It may even have the histologic characteristics of a true sarcoma and is then designated as malignant giant cell tumor. When this happens the future course of the disease is that of a sarcoma.

It is apparent that giant cell tumor is an unpredictable neoplasm and that controversy still exists as to how best to treat it. Recurrence often follows both surgical and x-ray therapy. Some more uniformly satisfactory method of treatment is needed. At present, however, the following criteria are suggested:

Conservative surgery for accessible tumors, such as those about the knee, wrist, ankle or shoulder, is recommended. If resection of the tumor-bearing portion of bone is possible it offers an excellent prospect of cure; otherwise curettage, chemical cauterization and bone chip implantation may be employed. Should a recurrence take place a second curettage is justified. If tissue from this second operation presents the same "benign" histologic features as were seen in the first operative specimen one can await results. Some of these second curettages may be successful.

If, on the other hand, the pathologist describes a definite change in the stroma, perhaps reporting it as "aggressive" or "borderline" one should be prepared for another recurrence and radical surgery will then be required. Of course, if the microscopic features are those of a malignant (grade III) tumor, amputation should be performed promptly. We have no evidence that radiation therapy can control a malignant giant cell tumor.

For those cases in which the primary site is considered surgically inaccessible, initial radiation is the preferred method. Such treatment should seldom exceed a tumor dose of 2,800 to 3,000 r. If this fails to control the process further courses of x-ray treatment are unlikely to do so and amputation must be considered. Curettage following failure of radiation is not recommended, nor is radiation generally desirable following failure of curettage. Occasional exceptions to the latter course have been observed. Resection after a tumor has recurred following primary radiation is sometimes successful. Indeed, primary resection for giant cell tumor deserves wider employment as an alternative to curettage because following resection the recurrence rate is low whereas with curettage it is comparatively high. We have no record of a case in which adequate resection of a benign giant cell tumor performed as the primary method of treatment was followed by a recurrence.

When amputation is performed for malignant giant cell tumor the five-year survival rate is higher than that obtainable in most other varieties of bone sarcoma.

Finally, the histologic grading of giant cell tumors by an experienced pathologist is a valuable guide in selecting the appropriate therapy. The unpredictable character of this tumor must be appreciated and the prognosis, therefore, guarded.

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Ovariectomy and Adrenalectomy for Treatment of Metastatic Cancer of the Breast

JOHN B. DAVIS, M.D., *Omaha, Nebraska*

From the Department of Surgery, University of Nebraska College of Medicine, Omaha, Nebraska.

CANCER of the breast is the leading cause of death among women in the mid-period of life and represents 21.7 per cent of all cancers in females [4]. It is readily apparent that in the total care of mammary cancer the palliative treatment of advanced, recurrent and metastatic disease has become a problem of major magnitude in clinical management. As the disease becomes disseminated, a systemic approach to treatment is required.

The purpose of this paper is to outline the historical development, rationale and results of bilateral ovariectomy and adrenalectomy in the palliative treatment of disseminated cancer of the breast. By palliation is meant the reduction of pain, the healing of ulcerated lesions as well as pathologic fractures, the reduction in size of tumor masses and pleural and peritoneal effusions, and prolongation of useful life expectancy.

HISTORICAL REVIEW

In 1916 Lathrop and Loeb [8] showed that in a cancer-bearing strain of mice the removal of the ovaries before the age of six months significantly lowered the incidence of cancer of the breast.

In 1932 Lacassagne [7] produced cancer of the breast within six months by injecting estrin into the male mice of a strain in which the females had a high incidence of spontaneous mammary carcinoma.

Murray [9], four years earlier, using a strain of mice in which cancer of the breast developed in 80 per cent of the females but in none of the males, had found that after castration and implantation of an ovary, the incidence in the males rose.

In 1939 Woolley, Fekete and Little [10] noted the return of irregular cycles of estrus in mice that had been spayed the day of birth. They hypothesized that the adrenal glands secreted the responsible estrogenic chemical.

Gardner [2] in 1941 noted the development of vaginal and uterine epithelial changes compatible with estrogenic activity in spayed mice. Some of the animals were also noted to have developed adrenal tumors.

At the clinical level, Herrell [3], in 1937 found the incidence of cancer of the breast after bilateral ovariectomy to be 1.5 per cent in 1,906 patients, while in a control group of 1,011 women of similar age it was 15.4 per cent.

In 1947 Horsley [5] reported a higher incidence of five-year cures in those women treated initially by radical mastectomy and bilateral ovariectomy, as compared to those treated with radical mastectomy only.

The first clinical use of hormonal therapy in cancer of the breast was undertaken in 1896 by Sir George Beatson [1] who reported clinical improvement after removal of the ovaries in two of three patients with far-advanced mammary cancer.

Bilateral ovariectomy was often followed by a remission. Relapse occurred later. On the theory that the cancer was again activated by fresh hormones released from elsewhere in the body, Huggins in 1951 performed adrenalectomy in addition to castration. This was followed by another remission in a large percentage of patients.

Even after both bilateral ovariectomy and adrenalectomy (and/or hypophysectomy) the disease again recurs and ultimately results in death. This must mean that tumors lose their dependence on hormones and become more autonomous in the course of their natural history. Hormonal factors which were necessary

for the initiation of a neoplasm may not be indispensable for its maintenance.

ENDOCRINOLOGY

Estrogens have been proved to be carcinogenic and have a decided role in the production and maintenance of many cancers of the breast. The pituitary gland, in addition to its gonadotropic stimulation of estogenic activity in the ovaries and adrenals, may have an additional direct stimulation of the tumor. The specific stimulant is unknown. The endocrinologic aspects are illustrated in Figure 1.

It can be seen that removal of the ovaries will rid the body of its primary source of estrogen and the removal of the adrenals removes all the remaining supply. This leaves an unknown stimulation directly from the pituitary. The rationale of hormonal therapy (thyroid extract, testosterone and cortisone) can be seen. The occasional effectiveness of estrogen cannot so easily be understood.

SELECTION OF PATIENTS

Early in the course of experimental ablative surgery for advanced cancer of the breast, much was written on various indications and contraindications to ovariectomy and adrenalectomy. These included such things as the age of the patient, the grade of the original tumor, calcium balance studies with estrogenic stimulation, the length of elapsed time between the original radical mastectomy and the development of metastases, prior response to hormonal therapy, prior response to ovarian ablation, and other tests. One by one these tests have proved to be of limited or no value. At present the only partially acceptable indication that adrenalectomy will be of value is remission following bilateral ovariectomy.

It would seem, then, that any person afflicted with early or advanced disseminated cancer of the breast should be considered a candidate for this form of therapy.

RESULTS

Because of the differences in the scientific interpretations of those reporting effects of ovariectomy and adrenalectomy, there is a wide range in statistical data concerning the results. Some observers make great efforts to distinguish between objective and subjective improvement, whereas others proclaim marked improvement in large numbers of cases based on subjective effects only. In terms of the criteria of palliation mentioned earlier in this paper, the over-all reported results of remission, collected from reports in the literature on 389 cases, is 48.7 per cent with an operative mortality of 7.9 per cent [6]. In a series of eleven patients operated upon by Dr. Herbert H. Davis and the author there was a dramatic remission in nine patients (82 per cent) with no operative deaths.

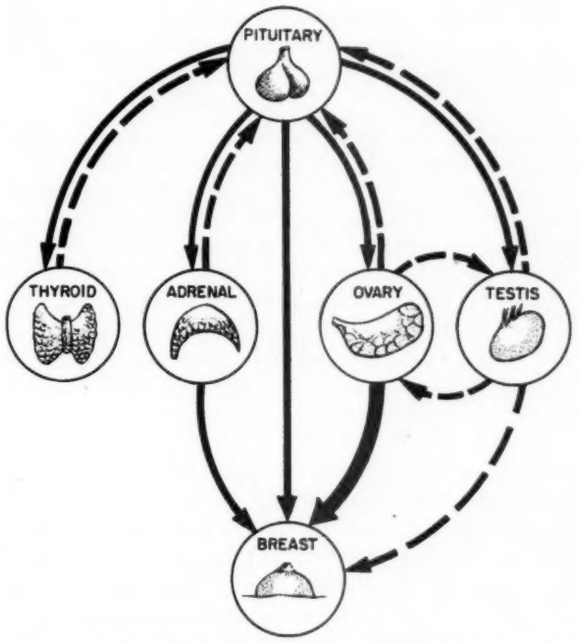

FIG. 1. Endocrinology. Diagram shows the sources of estrogenic stimulation of cancer of the breast plus an as yet unknown type of direct stimulation from the pituitary gland. The unbroken lines indicate stimulation and the broken lines indicate inhibition.

CASE REPORTS

CASE 1. A forty-three year old white woman underwent right radical mastectomy for scirrhous carcinoma on July 11, 1946. In January, 1954, multiple bony metastases were found, with pain and pleural effusion with shortness of breath. X-ray therapy was started. Shortness of breath became worse and the patient had to receive continuous O_2 therapy and repeated paracenteses. Bilateral ovariectomy and adrenalectomy was performed in three stages, the last one on August 20, 1954. By October, 1954, the patient was fully ambulatory at home with no shortness of breath or bone pain. There was no more pleural effusion. The patient remained well until March, 1955, at which time symptoms returned. She died on August 17, 1955.

CASE II. A fifty-six year old white woman had carcinoma en cuirasse in May, 1954. Biopsy of a node at that time confirmed the diagnosis. X-ray therapy and testosterone were started. By August, 1954, the patient showed metastases to the spine with severe pain in the back. Bilateral ovariectomy and adrenalectomy was performed in two stages; the procedure was completed on September 4, 1954. The patient was then asymptomatic (completely free of pain) for the next eighteen months, finally dying with convulsions on May 8, 1956.

CASE III. A forty-two year old white woman underwent left radical mastectomy for poorly differentiated duct type adenocarcinoma on May 6, 1952. By April, 1955, the patient had multiple metastases in her ribs, with many pathologic fractures and severe pain causing her to remain in bed at all times. Bilateral ovariectomy and adrenalectomy in two stages was completed on May 23, 1955. For the next seven months the patient was entirely free of pain, completely ambulatory and gaining weight. She died suddenly in January, 1956.

CASE IV. A forty-seven year old white woman underwent left radical mastectomy for adenocarcinoma on February 21, 1949, and right radical mastectomy for duct cell carcinoma on February 22, 1953. In September, 1954, the patient had multiple skin and bony metastases and severe back pain. X-ray therapy and testosterone were started, and there was much improvement for two months. In December, 1954, more skin metastases, skull metastases and a partial facial paralysis developed.

Bilateral ovariectomy and adrenalectomy was performed in two stages, completed on July 8, 1955. Following this the patient showed remarkable improvement with complete disappearance of the skin metastases and facial paralysis. She lived a normal life until she died suddenly on October 18, 1955.

CASE V. A forty-three year old white woman was seen on August 24, 1955, with multiple metastases from a previously operated mammary carcinoma and paralysis of her left arm and leg. Hemoglobin was 4 gm. per cent. Bilateral ovariectomy and adrenalectomy was performed in two stages, finished September 12, 1955. By September 26th there was some relief of the left hemiplegia and the patient felt much better. She died of cerebral metastases in October, 1955.

CASE VI. A thirty-nine year old white woman had clinical inflammatory carcinoma of the left breast, with the primary lesion being ulcerated. Bilateral ovariectomy and adrenalectomy was performed in two stages and completed on September 9, 1955. The patient showed marked improvement within two weeks and by May, 1956, the breast was entirely normal in size, shape, texture and appearance. She has remained completely well and clinically free of disease until the present time.

CASE VII. A fifty year old white woman was seen on February 7, 1956, with a clinically inoperable cancer of the right breast. A supraclavicular node biopsy two days later proved the diagnosis of poorly differentiated adenocarcinoma. Bilateral ovariectomy and adrenalectomy was performed in two stages, completed on February 28, 1956. The tumor regressed rapidly after this but in May, 1956, ascites developed and the patient died on May 5th.

CASE VIII. A forty-eight year old white woman had a biopsy of the right breast in 1951. The specimen showed intraductal carcinoma, for which x-ray therapy was instituted. In 1952 a right supraclavicular mass developed which progressively enlarged until in 1956 there was massive edema of the right arm with paralysis and severe pain.

Bilateral adrenalectomy and ovariectomy was performed in one stage on August 17, 1956. Within one week the pain disappeared and some function of the arm returned. In December, 1956, the arm had normal function and no pain, and the right supraclavicular mass was nearly gone. In March, 1957, a cough, mild headaches and blurring of vision in the left eye developed, and the right supraclavicular mass returned. She died with convulsions on April 4, 1957.

CASE IX. A forty-eight year old white woman underwent right radical mastectomy for poorly differentiated duct type carcinoma on February 10, 1953. In November, 1956, she suffered a pathologic fracture of her left hip in an area of massive metastases. Bilateral adrenalectomy and ovariectomy was performed on November 23, 1956, followed by healing of the fracture and gradual disappearance of the metastatic lesion. The patient has remained well to date.

CASE X. A forty-eight year old white woman underwent right radical mastectomy for duct cell carcinoma on December 13, 1953. In March, 1957, the patient had a large mass in the right side of her neck, multiple bony metastases, and felt tired and weak.

Bilateral ovariectomy and adrenalectomy was performed on March 14, 1957. By August, 1957, the patient had gained weight and strength; she had no pain, the mass in the cervical area had disappeared, and x-ray films showed healing of the bony metastases. In October, 1957, the bony metastases were again enlarging and testosterone therapy was started.

CASE XI. A forty year old white woman underwent right radical mastectomy for duct cell carcinoma on July 8, 1954. In November, 1956, a recurrent lesion developed next to the sternum subcutaneously and arising from the internal mammary nodes. The lesion was partially excised, the remaining portion cauterized and then treated by x-ray. In March, 1957, a large mass developed in the opposite axilla which could not be safely removed. A biopsy showed metastatic duct cell carcinoma.

Bilateral adrenalectomy (patient had undergone previous bilateral ovariectomy) was performed on March 27th. Following this the mass in the left axilla disappeared; the patient has resumed a normal life and remains clinically free of disease.

SUMMARY

Estrogen has been proved to be a carcinogenic agent responsible for the development of many, if not all, mammary cancers. The historical development and endocrinology of the concept of temporarily controlling and effectively palliating disseminated cancer of the breast by removal of the hormone sources has been briefly outlined.

At present there is no clear-cut criterion useful in selecting patients for adrenalectomy. It seems apparent that any person afflicted with disseminated cancer of the breast should be considered a candidate for this form of therapy.

To the results of this therapy on 389 cases reported in the literature are added eleven more cases, in nine of which marked palliation was received.

Bilateral ovariectomy and adrenalectomies are worth while operations in the palliative therapy of disseminated cancer of the breast in that they have a low operative mortality rate and prolong the useful life expectancy of nearly one-half the patients.

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Osteogenic Sarcoma of the Jaws and Facial Bones

LYLE V. KRAGH, M.D., DAVID C. DAHLIN, M.D. AND JOHN B. ERICH, M.D.,
Rochester, Minnesota

From the Sections of Surgical Pathology and Plastic Surgery, Mayo Clinic and Mayo Foundation, Rochester, Minnesota. The Mayo Foundation, Rochester, Minnesota, is a part of the Graduate School of the University of Minnesota. Abridgment of thesis submitted by Dr. Kragh to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Plastic Surgery.

AN extremely poor prognosis for osteogenic sarcoma of the jaws or facial bones has been commonly asserted, although the total number of reported cases is small; Richards and Coleman [*19*] accepted only seventeen from the literature in their review published in 1957. A study of the forty-four cases of osteogenic sarcoma of these bones in the files of the Mayo Clinic gives a more optimistic view regarding results of treatment of these tumors.

GENERAL BACKGROUND

Ewing [*7*] considered osteogenic sarcomas to be derived from ancestors of cells which, when fully differentiated, are known as osteoblasts. Phemister [*17*] in 1930, stated that bone sarcomas that consist largely of cartilage are best designated as chondrosarcomas. The revised classification of Ewing [*7*], published in 1939, separated chondrosarcomas from the osteogenic series. Lichtenstein and Jaffe [*13*] outlined criteria for the diagnosis of chondrosarcoma, and the former [*12*] reaffirmed the necessity of removal of chondrosarcomas from the osteogenic group. He emphasized that those tumors that show production of osteoid tissue by malignant cells fall into the osteogenic-sarcoma group although tumor cartilage may be a prominent feature of some of them. Coventry and Dahlin [*3*], in their study of bone tumors encountered at the Mayo Clinic, found 490 osteogenic sarcomas and 218 chondrosarcomas. They employed the same criteria as those outlined by Lichtenstein for differentiation of chondrosarcoma from osteogenic sarcoma. Pure fibrosarcomas were separated from these groups.

Ringertz [*20*] studied 391 malignant tumors of the nasal and paranasal cavities, three of which were osteogenic sarcomas. New and Cabot [*16*], in their report on treatment of 295 tumors of the upper jaw and antrum, stated that nine were fibrosarcomas or osteosarcomas. Geschickter [*9*], in a report on 323 tumors of the jaws, forty-four of which were malignant osseous tumors, included seventeen osteogenic sarcomas. Coley [*2*] reported that thirty-five histologically confirmed sarcomas of the jaws were seen during an eighteen-year period at Memorial Hospital, New York. Nineteen of these were osteogenic sarcomas and thirteen were chondrosarcomas.

In a study of 1,736 cases of Paget's disease of bone at the Mayo Clinic, Porretta [*18*] found only sixteen patients in whom sarcoma subsequently developed, an incidence of 0.9 per cent. None of these were in the jawbones. None of the ninety patients with Paget's disease of the jaws studied by Funk [*8*] showed any evidence of malignant change. It is now generally conceded that radiation of normal bone or benign lesions of bone may induce sarcoma in a small percentage of cases. For the years up to 1955, Sabanas and associates [*21*] were able to find in the literature more than fifty examples of postradiation sarcoma of bone, and they presented an additional seventeen. Three of their cases of sarcoma occurred in the jaws and are included in the present study.

It is now generally considered that osteogenic sarcoma of the extremity is best treated by amputation well proximal to the tumor, if possible through the bone above the involved bone.

Lichtenstein [12] stated that although the cure rate from surgical treatment is low in osteogenic sarcoma, the benefit from radiation therapy is almost nil.

The problem of benign and malignant tumors of the jaws has been discussed by Erich [6]. Devine and associates [5] recently reviewed the history of treatment of malignant tumors of the nose and paranasal sinuses. Radical surgical removal, occasionally combined with cautery, was the treatment given these lesions during the eighteenth and nineteenth centuries. The operative mortality rate from these procedures was very high, as high as 30 per cent. During the early part of the twentieth century the operative mortality rate decreased, probably owing to less extensive resection, use of local anesthesia and tracheal intubation. About 1920 electrosurgery had its advent. After the use of electrosurgical measures and radium, New [15] presented far superior results in the treatment of malignant tumors of the upper jaw and sinuses than had been obtained previously with open surgical methods. Recently there has been a tendency to return to radical open surgical removal of these neoplasms. The relatively safe performance of these extensive operative procedures has been due to better control of blood loss, shock and infections, to improvements in anesthesia, to judicious replacement of blood and to the use of antibiotics.

MATERIAL AND METHOD OF PRESENT STUDY

The forty-four osteogenic sarcomas of the jaws and facial bones included in the present study were encountered at the Mayo Clinic prior to March, 1957. Tumors that arose in the region of the maxillary or ethmoid sinuses were included; those that arose from the region of the nasopharynx, cranial base, calvarium or frontal sinuses were excluded. The gross and microscopic specimens were studied. The case records, including roentgenograms or reports of them, were reviewed, and follow-up information was obtained. One of the cases (Case 17) of this series was reported recently by Richards and Coleman [19].

CLINICAL FEATURES

Location. Nineteen of the forty-four tumors in the present series arose in the mandible, fourteen in the maxilla and two in the ethmoid region. The remaining nine tumors arose either primarily in the walls of the antrum, or primarily in the main portion of the maxilla and secondarily invaded the antrum, so that determination of their exact site of origin was impossible. Twenty-four of the sarcomas were on the right, eighteen on the left and two in the midline.

Sex and Age. There were twenty-five males and nineteen females. The average age of the patients was 33.2 years, with the extremes being eleven and sixty-two years. Slightly more than one-fifth of the cases occurred in each of the decades of life from the second through the fifth.

Etiologic Factors. In only two of the patients was there a history of significant trauma, and in both it had occurred many years prior to the onset of sarcoma.

Four osteogenic sarcomas arose in tissue that had been radiated previously for benign conditions. Three of these (Cases 3, 24 and 26) were reported by Sabanas and associates [21]. Two were sarcomas that arose in pre-existing fibrous dysplasia, the third followed treatment of a giant cell reparative granuloma and the fourth developed after radiation for keloids about the chin. The latent interval between radiation and onset of the sarcoma averaged 14.7 years (nine, twenty-one, seven and twenty-two years, respectively).

Symptoms. The presenting symptom of all but one of the nineteen mandibular tumors was a mass. This varied from a diffuse swelling over the involved region to a firm localized or even bony hard mass. Pain was a presenting symptom of eight of the mandibular tumors. Numbness of the chin and lip was mentioned as a symptom in five instances; this symptom was probably due to involvement of the inferior alveolar nerve in the mandibular canal. Limitation of jaw movement and displacement of teeth were noted in one instance each.

Twelve of the fourteen tumors that arose in the upper jaw, its alveoli or the palate produced a mass discernible to the patient, and four of them produced pain. Limitation of jaw movement, nasal obstruction, eye symptoms and displacement of teeth were each noted once.

Of the nine patients with predominantly antral involvement, seven had noticed a mass or swelling of the cheek, and five had pain. Two patients had nasal obstruction and one each had nasal discharge, epistaxis, numbness due to involvement of the infraorbital nerve and "eye symptoms."

Duration of Symptoms. In the patients with mandibular tumors the average interval from the onset of first symptom to first therapeutic attempt was 3.4 months, the intervals ranging from one to nine months. In those with maxillary involvement the interval from first symptom to first therapeutic attempt ranged from one to twelve months, the mean being 4.3 months. This interval for the antral lesions ranged from one to twenty months, the mean being 3.6 months. The patients in whom the interval from onset of first symptom to first therapeutic attempt was longer did not appear to have less malignant tumors. Of the nine patients whose initial interval was more than six months (all locations), only one survived five years after definitive treatment at the Clinic.

Physical Findings. A mass was noted by the examiner in sixteen of the nineteen patients with mandibular sarcoma, and trismus was present in one. The mass was usually a nonulcerating enlargement about the alveolar ridge.

Eleven of the fourteen maxillary tumors produced a mass that was noted by the examiner. Tooth displacement and eye displacement were each noted once, as was one instance of postradiation changes in the skin.

A swelling of the cheek or an intranasal mass, or both, were noted by the examiner in eight of the nine patients with antral involvement. Eye signs (proptosis or eye displacement) were noted in five of the nine patients.

Roentgenographic Findings. In most instances the classic zones of destruction with or without regions of increased density were found. A radiating "sunburst" of neoplastic bone was uncommon. Nine of the mandibular tumors were predominantly osteolytic, whereas four were predominantly radiopaque. Roentgenographic findings were interpreted as "negative" in five of the mandibular osteogenic sarcomas, and were not recorded in one. Four of the five mandibles with "negative" roentgenographic findings had been subjected to local excision of the tumor prior to arrival of the patient at the Mayo Clinic. Three of these were treated surgically at the Clinic and had pathologically verified recurrent tumors at the time of the "negative" roentgenographic findings. One patient (Case 8) with "negative" dental and mandibular roentgenographic findings, who had had no prior therapy, had an osteogenic sarcoma that produced a mass on the buccal surface of the gingiva on the left, and died with local recurrence twenty-two months after the first therapeutic attempt. Roentgenographic examination of the recurrent local lesion, however, revealed both osteolytic changes and proliferating radiating spicules.

Four of thirteen maxillary tumors examined were predominantly osteolytic, and three were predominantly radiopaque. Minimal diffuse cloudiness of the antrum was noted in four, and only postoperative bony changes in two.

Seven of ten antral and ethmoid tumors examined were predominantly osteolytic, and two were predominantly radiopaque. One patient exhibited only diffuse cloudiness of the antrum.

The failure of roentgenographic examination to assist in the diagnosis of some of these tumors was due largely to treatment prior to examination here. As stated before, four of the five patients whose mandibles were reported as "negative" roentgenographically had had local excision of the tumor prior to arrival at the Mayo Clinic. Likewise, two of the maxillary tumors exhibited only "postoperative changes" roentgenographically. Three of these seven lesions (mandible and maxilla) showed typical osteolytic or osteosclerotic features when examined later at the time of local recurrence.

PATHOLOGIC FEATURES

Gross study of the tumors was severely restricted in many cases because only fragments of the tumor had been removed for biopsy. In those instances in which radical resection had been employed instead of destruction of the tumor by diathermy, entire specimens preserved in formalin were available for study. The lesional regions displayed destruction of the osseous structures and variable extension of the tumors beyond the normal limits of the bone. Tumors varied in texture from soft and granular to densely sclerotic. Some of them had predominant fibrous or cartilaginous regions. The typical radiating spicules of extraosseous neoplastic bone were sometimes seen.

Histologically, two criteria had to be met for a diagnosis of osteosarcoma: evidence of malignancy in the proliferating cells, and osteoid production by at least some of the malignant cells. (Figs. 1, 2 and 3.) Zones of such osteoid may be sparse or may dominate the microscopic picture. Since tumors exhibiting these criteria may be predominantly cartilaginous or fibrous, the tumors were subdivided

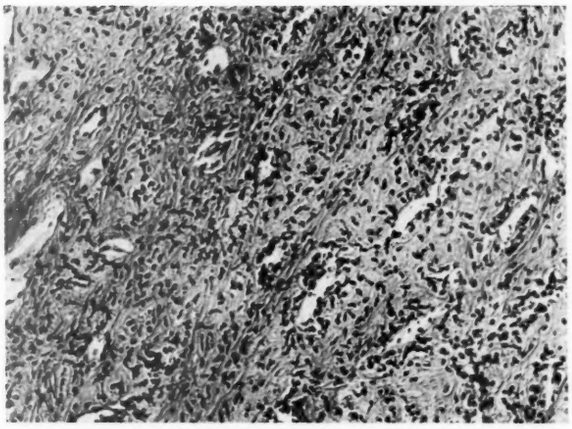

FIG. 1. Case 23. Metastatic osteoblastic osteogenic sarcoma of spinal column. The primary lesion of the maxillary alveolus had been treated by electrocoagulation eleven years previously. Hematoxylin and eosin stain.

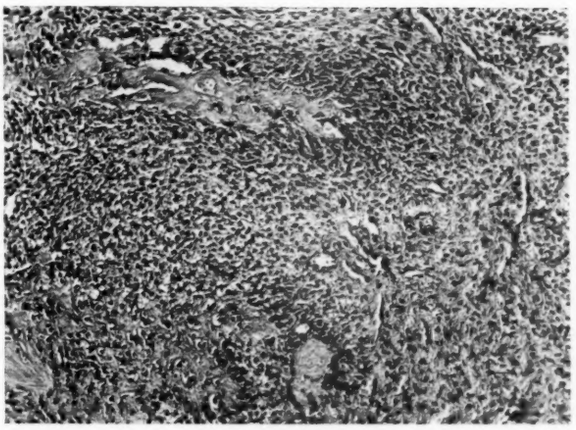

FIG. 2. Case 15. Fibroblastic osteogenic sarcoma, grade 2, of mandible. Note predominating spindle cell component with osteoid production near top and bottom. This patient was living seven and a half years after radical diathermy removal of the tumor. Hematoxylin and eosin stain.

accordingly. Twenty-two were designated as chondroblastic, fourteen as osteoblastic and eight as fibroblastic osteogenic sarcomas. This subclassification takes into account the well known fact that variation in the histologic appearance of osteosarcomas occurs, as evidenced by such terms as "fibrochondro-osteosarcoma" and "osteochondrosarcoma" that have been applied to them. Ten pure fibrosarcomas and eight chondrosarcomas were excluded from this series.

The tumors were graded 1 to 4 according to the method of Broders, in which grade 4 is the least differentiated type. Three sarcomas were grade 1, twenty-three grade 2, sixteen grade 3, and two grade 4.

In eight cases the regional lymph nodes were available for study, and in no instance were involved nodes found. Two patients who died here had no metastatic lesions at necropsy. Pulmonary or widespread metastasis was known to have occurred in only three of the patients. Since the final details of the remaining fatal cases are lacking, the exact extent of spread is unknown. In the majority, however, death appeared to be due to local recurrence, inanition and possible intracranial extension, with systemic spread playing only an occasional role.

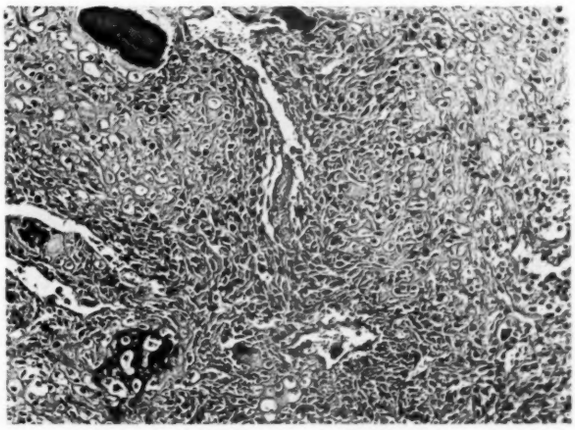

FIG. 3. Case 11. Chondroblastic osteogenic sarcoma of mandible. Osteoid production directly from malignant cells is seen near the center of the picture. Two limited surgical removals were followed by hemimandibulectomy. Patient was living and well eleven years after hemimandibulectomy. Hematoxylin and eosin stain.

DIFFERENTIAL DIAGNOSIS

The main lesions to be considered in the differential diagnosis of osteogenic sarcoma of the jaws and facial bones are chondrosarcoma, fibrosarcoma, fibrous dysplasia and giant cell reparative granuloma. Chondrosarcoma is composed entirely of malignant cartilage in contrast to chondroblastic osteogenic sarcoma, in which, although the tumor differentiates along cartilaginous lines, the neoplastic cells produce osteoid directly in at least some foci. Fibrosarcoma of bone, likewise, is a primary malignant fibroblastic tumor, whereas fibroblastic osteogenic sarcoma is a tumor whose neoplastic cells produce osteoid, although the tumor develops predominantly along fibroblastic lines. Fibrous dysplasia may be characterized by very cellular tissue, and superficially it may

resemble osteogenic sarcoma. The lack of nuclear anaplasia and the characteristic meaningless masses of osteoid and bone distinguish the former. Mitotic figures and production of bone are found in most giant cell reparative granulomas but, again, lack of hyperchromatism and other nuclear abnormalities differentiate this lesion from sarcoma.

TREATMENT

The treatment instituted both elsewhere and at the Mayo Clinic for the forty-four osteogenic sarcomas is given in Tables I, II and III. Only treatment directed toward eradication of the tumor is listed. Plastic and reconstructive procedures have been omitted. The great majority of patients received surgical treatment, with or without adjunctive radiation. Inadequate surgical treatment, employed in several cases, resulted from such factors as cosmetic limitations, extent of tumor and "underdiagnosis" pathologically. Several patients who received limited surgical treatment initially were cured subsequently by more radical therapy. Radical treatment consisted of wide surgical excision or diathermy destruction of the lesion and surrounding tissues.

The end results of treatment are likewise given in Tables I, II and III. Follow-up data were available in all cases except one. Treatment of this patient (Case 31) was considered palliative, and she is presumed to be dead. Eleven of the forty-four patients were still living at the time of follow-up in March, 1957, and in addition, one patient (Case 14) was known to be alive and well in 1953, six years after treatment. Of the thirty-five patients treated prior to March, 1952, eleven are known to have lived for periods ranging from five to twenty-eight years after their first definitive treatment here. Six of these had mandibular, four had maxillary, and one had antral sarcoma. Of these eleven survivors, five had chondroblastic, four fibroblastic and two osteoblastic osteogenic sarcomas. Neither patient with primarily ethmoidal involvement survived five years. Two patients (Cases 23 and 40) died of recurrent tumor or metastasis thirteen and six years, respectively, after their first treatment here.

COMMENTS

Osteogenic sarcoma arising in the jaws or facial bones is relatively rare. When compared to other sarcomas in these locations, however, it is not uncommon, as evidenced by the fact that Litzow [14] found only ten cases of pure fibrosarcoma of the maxilla and mandible in the same series from which these forty-four osteogenic sarcomas were derived. Furthermore, in this same series we uncovered, and excluded, only eight pure chondrosarcomas.

Osteogenic sarcoma, in general, affects predominantly the younger age groups. In Coventry and Dahlin's [3] series of 430 osteogenic sarcomas exclusive of those of the jaws and facial bones, by far the greatest number of patients were in the second decade of life. This same type of age distribution holds for most series of osteogenic sarcomas of the peripheral bones. In contrast, in the present series the average age was 33.2 years, which is considerably higher than for osteogenic sarcoma of other bones. Ringertz [20] stated that osteogenic sarcoma in the maxilla and paranasal sinuses occurs usually in adults of advanced age. The average age of patients with sarcoma of the jaw at the Memorial Hospital was thirty-six years, and in Geschickter's [9] series the ages ranged from thirteen to sixty-five years.

In our series 56.8 per cent of the sarcomas occurred in males. This is in line with the predominance of the male sex observed in larger series of osteogenic sarcomas involving other bones.

In our series of forty-four sarcomas, fourteen were designated as osteoblastic, twenty-two as chondroblastic and eight as fibroblastic osteogenic sarcomas (31.8, 50.0 and 18.2 per cent, respectively). In contrast, in Coventry and Dahlin's [3] series 50 per cent were osteoblastic, 27 per cent were chondroblastic and 23 per cent were fibroblastic osteogenic sarcomas.

The degree of malignancy of osteogenic sarcomas of the jaws and face is appreciably lower on the average than for this type of sarcoma in other bones. Whereas Coventry and Dahlin found that more than 80 per cent of their tumors were of grades 3 and 4, only 40.9 per cent of our sarcomas of the jaws were of these high grades, and 52.3 per cent were of grade 2 and 6.8 per cent of grade 1.

Four of the forty-four osteogenic sarcomas arose in bone that had been previously radiated. Inclusive of these four cases we were able to find reports of thirteen cases of postradiation osteogenic sarcoma of the jaws and facial bones. (Table IV.) Not included in the table is one case by Skolnik and associates [22] in which an osteogenic sarcoma of the mastoid appeared

TABLE 1

OSTEOGENIC SARCOMA OF THE MANDIBLE (NINETEEN MAYO CLINIC CASES)

Case	Age (yr.), Sex	Histologic Type, Grade	Previous Therapy (elsewhere)	Operation at Clinic	Other Therapy	Living (yr.)	Dead (yr. after therapy at clinic)
1	39, M	O,* 2	DE†	S, Apr. 1916	Ra, Ro	.....	1
2	36, M	C,* 2	Ro† (2 mo.)	B, June 1924	Ra	.....	⅔
3	36, M	C, 3	Ra† to keloids of chin and neck (1925);‡ B† (3 mo.); B (3 wk.)	DR, Mar. 1947	None	10	...
4	11, M	C, 2	Ro, Ra; B (3 wk.)	B, May 1927	Ra; S elsewhere	.....	1
5	41, M	O, 2	B (5 days)	None	Ra	.....	½
6	43, F	C, 3	DE; S† (9 mo.)	DR, 1929; DR, 1931; DR, 1934	Ra, 1934; Ro, 1934	28	...
7	45, M	C, 2	DE; DE; B	DR, Apr. 1934	None	.....	1
8	26, M	C, 2	None	DR, May 1945; DR, Aug. 1945; H,§ Apr. 1946	Ra, June 1945; Ro, Jan., July, Aug., Nov., Dec. 1946	.....	2
9	12, F	O, 2	S (2 mo.); Ro (2 wk.)	B, Dec., 1938	None	.....	¼
10	43, F	O, 2	S (8 mo.); Ro (5 mo.)	DR, Feb. 1940; DR, July 1940; jaw excision, Dec. 1940	Ro, Sept. 1940	17	...
11	16, M	C, 3	B (2 mo.)	S, July 1944; S, Sept. 1945; H, Nov. 1945	None	11	...
12	49, F	C, 1	S (3 wk.)	S, July 1945	Ro, July, Oct., Dec. 1945, Mar., June 1946	.....	1
13	19, F	C, 2	None	S, May 1946; DR, Aug. 1946; DR, Oct. 1946	Ra, Oct. 1946, Feb., May 1947	.....	1
14	18, F	F,* 2	B (6 mo.)	DR, May 1947	None	6 (1953)	...
15	32, F	F, 2	S (5 mo.)	DR, Sept. 1949	None	8	...
16	60, F	O, 3	S; Ro (1 mo.)	None	Ra, Sept. 1952; Ro, elsewhere	.....	1
17	25, F	O, 3	DE (2 wk.)	H, Apr. 1953; S, May 1954	Ra, Sept., Nov. 1955, Mar., May 1956; Ro, Mar., July 1956	.....	3
18	36, F	O, 1	S (4 mo.); S (3 mo.)	DR, Oct. 1953; DR, Jan. 1954; DR, Sept. 1954	Ra, Dec. 1954, Feb., Apr. 1955; Ro, elsewhere	.....	2½
19	35, M	O, 3	Ro of fibrous dysplasia of mandible (1930); Ro of fibrous dysplasia of maxilla (1935); DR† (3 wk.)	H, Mar. 1957	Cobalt 60, Nov. 1956	6 mo.	...

* O = osteoblastic osteogenic sarcoma; C = chondroblastic osteogenic sarcoma; F = fibroblastic osteogenic sarcoma.

† DE = dental extraction; B = biopsy; DR = diathermy removal (electrocoagulation); S = open surgical treatment; Ro = roentgen therapy; Ra = radium therapy.

‡ In parentheses is given (1) the year in which the corresponding event occurred or (2) the interval by which the event preceded operation at clinic.

§ H = hemimandibulectomy.

TABLE II

OSTEOGENIC SARCOMA OF THE MAXILLA (FOURTEEN MAYO CLINIC CASES)

Case	Age (yr.), Sex	Histologic Type, Grade	Previous Therapy (elsewhere)	Operation at Clinic	Other Therapy	Living (yr.)	Dead (yr. after therapy at clinic)
20	48, M	C,* 2	None	S, Mar. 1912	Coley's serum	..	1½
21	62, M	O,* 3	DE†	DR,† Sept. 1913; DR, 4 times in Oct. 1913	None	..	Presumably
22	49, F	C, 2	S† (11 yr.);‡ S (4 yr.); S (2 yr.); Ro† (4 yr.); Ro (1 yr.)	B, Feb., 1939	Ro elsewhere	..	¾
23	26, M	O, 1	DE (6 mo.); S (1 mo.)	DR, Mar. 1939; DR, Apr. 1940; pneumonectomy, laminectomy	Ra, Mar. 1939, Apr. 1940; Ro, Mar., May, July 1949, Apr. 1951 (chest); Aug., Sept. 1951 (spine)	..	13
24	17, M	C, 3	Giant cell reparative granuloma excised (7 yr.); Ro, Ra†	DR, Oct. 1939; B, May 1940	Ra, Jan., May 1940	..	1
25	26, M	C, 2	S (9 mo.); S (6 mo.); Ro (6 mo.); Ro (1 mo.)	None	None	..	Yes
26	24, F	C, 2	Ro of fibrous dysplasia (9 yr.)	B, Aug. 1945	None	..	⅓
27	16, M	F,* 2	S (6 mo.); S (1 mo.)	DR, Jan. 1947	None	10	.....
28	25, M	C, 2	DE (2 mo.)	DR, July 1948	None	9	.....
29	47, M	C, 2	S (3 yr., 2½ yr., 2 yr., 1½ yr., 4 mo.); Ro (10 mo.)	DR, Feb. 1952	None	5	.....
30	30, M	C, 3	DE (15 mo.)	DR, Sept. 1953; B, Dec. 1954	None	..	3
31	52, F	C, 2	Benign tumors of mandible excised (1921, 1935, 1951); Ro of mandible (1951)	B, June 1954	None	..	Presumably
32	25, M	C, 2	S (2½ yr.); S (2 yr.); B† (1 mo.)	DR, July 1954	None	2	.....
33	23, F	C, 2	B (3 mo.)	S, May 1955	None	1½	.....

* O = osteoblastic osteogenic sarcoma; C = chondroblastic osteogenic sarcoma; F = fibroblastic osteogenic sarcoma.

† DE = dental extraction; B = biopsy; DR = diathermy removal (electrocoagulation); S = open surgical treatment; Ro = roentgen therapy; Ra = radium therapy.

‡ In parentheses is given (1) the year in which the corresponding event occurred or (2) the interval by which the event preceded operation at clinic.

TABLE III

OSTEOGENIC SARCOMA OF THE ANTRUM AND ETHMOID REGION (ELEVEN MAYO CLINIC CASES)

Case	Age (yr.), Sex	Site of Tumor	Histologic Type, Grade	Previous Therapy (elsewhere)	Operation at Clinic	Other Therapy	Dead (yr. after therapy at clinic)
34	38, M	Antrum	O,* 2	S (1 mo.)† ‡	B,† Jan. 1919	Ra, Jan. 1919	1/12
35	40, F	Maxilla, antrum	F,* 4	DE† (1 mo.)	B, Jan. 1936	Ra, Jan. 1936	1½
36	20, F	Maxilla, antrum	C,* 4	S (2 mo.); Ra,† Ro†	DR,† Feb. 1937; DR, Apr. 1937	Ra, Jan. 1937; Ra, Apr. 1937	½
37	18, M	Antrum	O, 2	Ro (6 mo.); S (1 mo.)	B, Oct. 1938	Ra, Oct. 1938; Ro elsewhere	Yes
38	35, M	Antrum	C, 3	S (3 mo.); S (2 mo.); Ro (1 mo.)	None	None	1/12
39	28, F	Antrum	C, 3	S (3 mo.); S (1 mo.); Ro (2 mo.); Ra (1 mo.)	None	None	Presumably
40	46, M	Maxilla, antrum	F, 3	S (1½ yr.); Ra (1½ yr.)	DR, Mar. 1945	S and Ra elsewhere	6
41	55, F	Maxilla, antrum	F, 2	DE (4 mo.)	DR, Mar. 1952	Ra, Mar., Nov. 1952, June 1953; Ro, Apr. 1952, Oct. 1953, Jan. 1954	3
42	15, F	Antrum	F, 3	None	DR, Feb. 1956; DR, July 1956; DR, Dec. 1956; DR, Jan. 1957	Ra, Oct. 1956; Cobalt 60, Feb. 1956	1
43	23, M	Ethmoid	O, 3	None	B, Apr. 1950	None	Presumably
44	53, M	Ethmoid	O, 3	None	S, Dec. 1951	Ra, Dec. 1951; Ro elsewhere	3

* O = osteoblastic osteogenic sarcoma; C = chondroblastic osteogenic sarcoma; F = fibroblastic osteogenic sarcoma.

† DE = dental extraction; B = biopsy; DR = diathermy removal (electrocoagulation); S = open surgical treatment; Ro = roentgen therapy; Ra = radium therapy.

‡ In parentheses is given (1) the year in which the corresponding event occurred or (2) the interval by which the event preceded operation at clinic.

four and a half years after roentgen therapy to the region for keloids. The case of mandibular fibrosarcoma of Kaae and Glahn [*11*] is likewise not included. The conclusion is obvious that one should avoid radiation of normal bone and benign disease of bone unless valid indications for its use exist.

None of the osteogenic sarcomas in this series arose in regions of demonstrable preexisting Paget's disease of bone.

In only three instances in the present series was systemic spread known to have occurred, although details of the terminal events were not known in many of the cases. No distant metastasis was found in the two cases in which necropsy was performed here. While some of these tumors run a very rapid course with early metastasis, some are less aggressive and recur locally for some time before they spread systemically. It appears, from a study of this

series and of cases reported in the literature, that death is usually caused by inanition or intracranial extension of a massively recurrent local tumor, with only occasionally regional nodal or systemic spread being a major factor. One might expect these sarcomas of the jaws to be somewhat less prone to early metastasis than are other osteogenic sarcomas, since they are, on the average, considerably less anaplastic.

TABLE IV
POSTRADIATION OSTEOGENIC SARCOMAS OF JAWS AND FACIAL BONES REPORTED IN THE LITERATURE

Author	Year Reported	Location	Age (yr.)	Latent Interval (yr.)
Cahan et al. [1]*	1948	Mandible	23	6
Cahan et al. [1]	1948	Maxilla	26	13
Cahan et al. [1]	1948	Ethmoid	9	6
Wolfe and Platt [24]	1949	Nasal bones	51	4
Wolfe and Platt [24]	1949	Nasal bones	34	18
Tebbet and Vickery [23]	1952	Ethmoid	9	6
Jones [10]	1953	Mandible	28	7
Sabanas et al. [21]	1956	Mandible	37	21
Sabanas et al. [21]	1956	Maxilla	24	9
Sabanas et al. [21]	1956	Maxilla	17	7
Skolnik et al. [22]	1956	Ethmoid	11	10
Cruz et al. [4]	1957	Mandible	67	15
Present case	1957	Mandible	35	21

* This tumor was possibly a fibrosarcoma.

The original treatment given to many of these patients was inadequate. The treatment given thirty-eight of them before coming to the Clinic is listed in Tables I, II and III. Much of the therapy was based on erroneous diagnosis, often diagnosis of a benign condition. It varied from minor dental and surgical procedures to major surgical and radiation therapy. None of the patients seen with recurrent sarcoma following surgical attempts at removal had had truly radical surgical treatment. It is at the first operation that the surgeon has the best opportunity to effect a cure. It is apparent that dentists and physicians should increase their index of suspicion so that correct diagnoses will be made earlier, when the tumors are smaller and more susceptible of cure. Several of our patients demonstrated that minimal or completely negative roentgenographic findings may contribute to the delay in diagnosis. Such cases point up the importance of detailed oral examination.

PROGNOSIS

The prognosis for osteogenic sarcoma of the jaws is surprisingly good, in spite of the frequent delay in proper therapy. Eleven of the thirty-five patients eligible for follow-up are known to have lived for more than five years. If one excludes the two patients known to have died after five years, there has still been a salvage of one-fourth of the patients. Several of the cured patients were initially treated by limited surgical means, but subsequently more radical treatment was successful. In six cases radical surgical or diathermy removal of the tumor without additional radiation therapy produced a "cure." Surgical removal plus radiation therapy produced a "cure" in the remaining five patients. No patient treated by radiation alone survived five years.

These relatively favorable data seem paradoxical when it is considered that the jaws and face are not as well adapted to radical ablative operations as are the extremities. Coventry and Dahlin [3] reported a five-year survival rate of only 19 per cent in their series of osteogenic sarcomas that excluded the jaws. The average lower grade and the increased percentage of the chondroblastic type of osteogenic sarcoma among tumors of the jaws both favor a better prognosis. The high incidence of the chondroblastic type of osteogenic sarcoma cannot in itself, however, explain the relatively good prognosis in our series. Coventry and Dahlin found the five-year survival rates for the three histologic types (chondroblastic, fibroblastic and osteoblastic) to be 22.7, 22.9 and 15.6 per cent, respectively, in their study of 430 osteogenic sarcomas of other bones. The predominance of the chondroblastic and fibroblastic types among the survivors in the present series is of questionable significance, furthermore, because of the small numbers involved. The fact that many of the sarcomas remain locally invasive for considerable time before metastasizing is, of course, the key to successful surgical therapy, but the reason for this indolent behavior is not clear. Osteogenic sarcomas in different bones may behave differently. For example, the prognosis for those of the tibia has been shown to be twice as good as the prognosis for those of the femur [3]. Tibial osteogenic sarcomas of all types and degrees of malignancy shared in this better prognosis when compared with corresponding types of femoral sarcomas.

Adequate therapy for osteogenic sarcomas of the jaws requires total removal of the neoplasm, getting well into normal, uninvolved

bone and soft tissues. This often requires such radical operative procedures as hemimandibulectomy or radical resection of the maxilla. In the present series, successful extirpation was accomplished by either surgical diathermy (electrocoagulation) or cold-knife operations. There has been a trend toward the latter approach in recent years. One must remember the capacity of these tumors to implant and recur locally, making it important to avoid breaking into the tumor during its removal. Prophylactic dissection of nodes is probably contraindicated because of the well known rarity of lymphogenous metastasis by osteogenic sarcoma. If a solitary metastatic focus develops in the lung or elsewhere, its removal may be indicated.

SUMMARY

Observations on forty-four osteogenic sarcomas of the jaws and facial bones demonstrate that surgical treatment affords a reasonable chance of cure. A tendency to late systemic spread and a relatively low average degree of malignancy are among the factors that contribute to successful therapy.

In the present series vague symptoms were commonly present and led to many dental and minor surgical procedures prior to establishment of the correct diagnosis. This fact emphasizes that a relatively painless non-ulcerating mass occurring in the upper or lower jaw, particularly about the alveolus, should suggest the possibility of osteogenic sarcoma. In the antral and ethmoid regions, early symptoms are lacking. Roentgenographic examination is extremely helpful in most instances, but definitive diagnosis depends on histologic studies.

Four of the sarcomas in this series arose in regions previously radiated for benign conditions of bone or soft tissue.

More alertness on the part of dentists and physicians would favor earlier correct diagnosis and treatment of osteogenic sarcoma of the jaw.

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Ectopic Mixed Salivary Tumours of Lips

K. D. SHARMA, M.B., B.S., M.SC., *Nagpur, Bombay State, India,* J. B. SHRIVASTAV, M.D., D.B., *Nagpur, Bombay State, India,* AND S. AGRAWAL, M.B., B.S., M.SC., *Jabalpur, Madhya Pradesh, India*

From the Department of Pathology and Bacteriology, Medical College, Nagpur, India.

ALTHOUGH there are excellent reviews of mixed tumours of both the major and minor salivary glands, few articles are devoted to those occurring at ectopic sites and particularly to those affecting the lips. In 1851 Sir James Paget (according to Cade [2]), was the first to describe a parotid tumour in the lip. Mixed tumours also occur at uncommon sites such as the palate, tongue, pharynx, larynx, neck, face, orbit, scalp, auditory canal and lacrimal glands. Eggers [4] reviewed a series of sixty-four cases of mixed tumours of the lips reported in the literature. This included four in the lower lip. Hamrick [8] brought the up-to-date record to eighty-two in the upper lip and five in the lower lip. Eggers [4] quoted no report in which more than three cases were attributed to any single author. A fairly large series of this tumour has been reported by Bernier [1]. Of nearly 600 mixed tumours examined from both the major and minor salivary glands, in the Armed Forces Institute of Pathology, Bernier found thirty-eight or nearly 6 per cent occurring on the lips. Thirty-five of these lesions affected the upper lip and only three the lower lip. In his Hunterian lecture delivered at the Royal College of Surgeons of England, Harrison [9] presented a large comprehensive series of eighty-two cases of these tumours, out of which only four occurred on the lips. In the present study six cases of mixed tumour of the lips are reported.

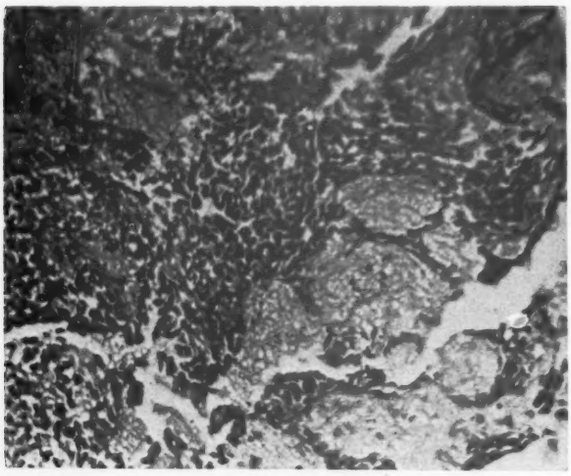

FIG. 1. Low power photomicrograph showing broad strips of epithelial cells embedded in myxoid stroma (Ehrlich's hematoxylin and eosin stain).

TABLE 1

Case No.	Age (yr.) and Sex	Site of Tumour	Duration of Illness (mo.)	Clinical Diagnosis
S 49-112	25, male	Upper lip	3	Lipoma
S 50-346	30, male	Upper lip	2	Mixed salivary tumour
S 51-89	12, male	Upper lip	..	Dermoid
S 51-282	30, female	Upper lip	..	Fibroma
S 52-816	14, female	Upper lip	12	Mixed salivary tumour
S 55-2179	12, male	Lower lip	..	Fibroma

Clinical Features. Table 1 summarizes some of the clinical features of these cases.

Gross and Microscopic Appearance. On gross examination these tumours ranged from 2 to 4.2 cm. in largest diameter. The sectioned surfaces were homogenous and greyish white. Some areas were semi-translucent and bluish tinged. In case No. S 55-2179 the tumour was almost entirely cartilaginous.

Microscopically these tumours were composed of both the epithelial and connective tissue elements. The epithelial masses were arranged in broad strips and columns or in a network of strands made up of these cells. (Fig. 1.) Well formed tubular structures were common. Acidophilic secretions had collected in these glands or in cystic spaces. These cell

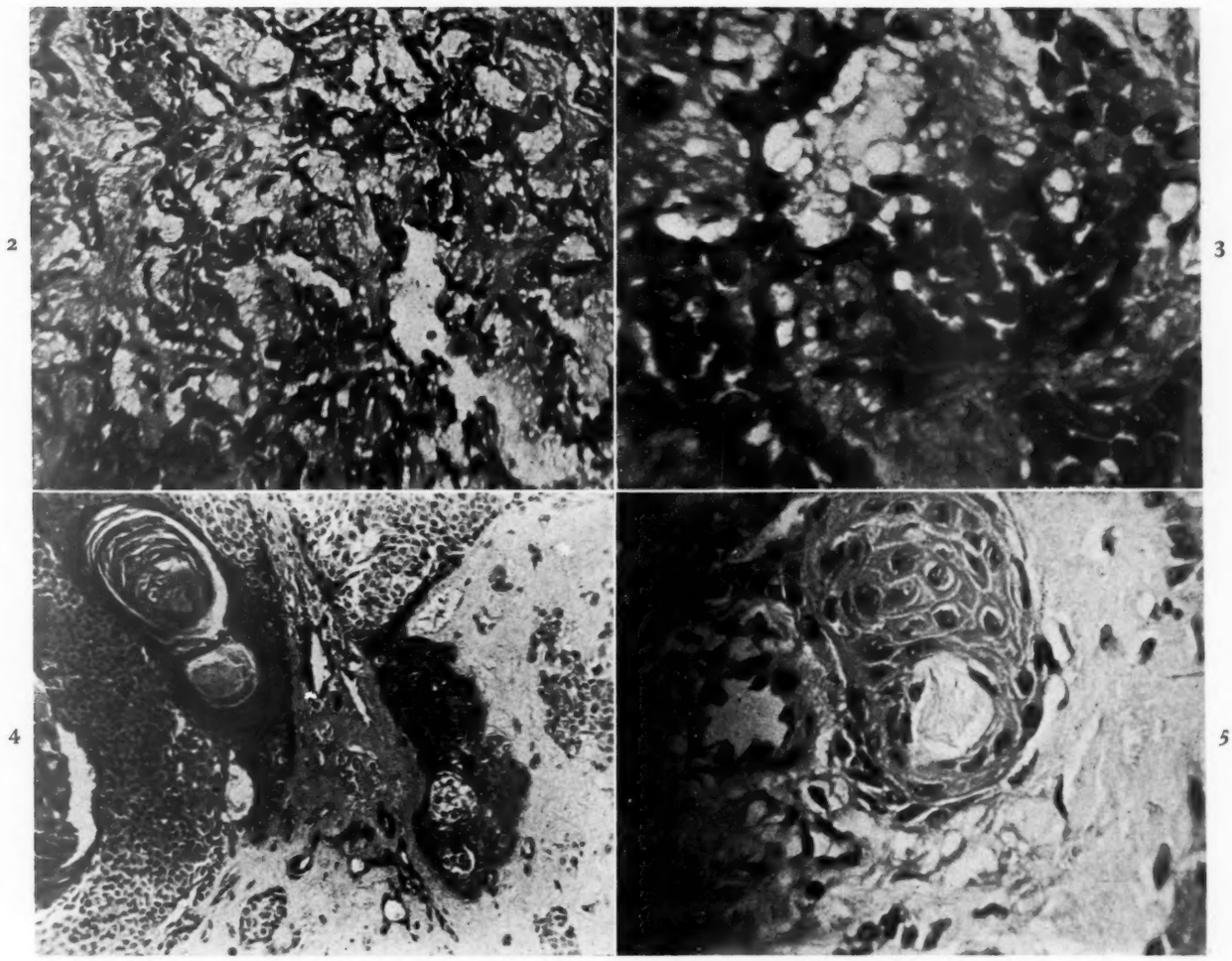

FIG. 2. Low power photomicrograph showing a loose myxoid stroma (Ehrlich's hematoxylin and eosin stain).

FIG. 3. High power photomicrograph showing the epithelial cells and the myxoid stroma (Ehrlich's hematoxylin and eosin stain).

FIG. 4. Low power photomicrograph showing squamous metaplasia of the glandular epithelium (Ehrlich's hematoxylin and eosin stain).

FIG. 5. High power photomicrograph showing the squamous metaplasia of the glandular epithelium (Ehrlich's hematoxylin and eosin stain).

TABLE II

Case No.	Epithelial Element	Formation of Cyst	Mucoid Connective Tissue	Chondroid Tissue	Squamous Metaplasia	Calcium Deposit	Mucus-Secreting Cells
S 49-112	Prominent	+	Slight	.....	+++	....	+
S 50-346	Moderate	.....	Moderate	.....	.....	....	..
S 51-89	Moderate	Slight	Moderate	.....	++	++	..
S 51-282	Moderate	.....	Moderate	++	++	....	..
S 52-816	Prominent	.....	Slight	.....	.....	....	..
S 55-2179	.....	.....	Slight	++++	.....	....	..

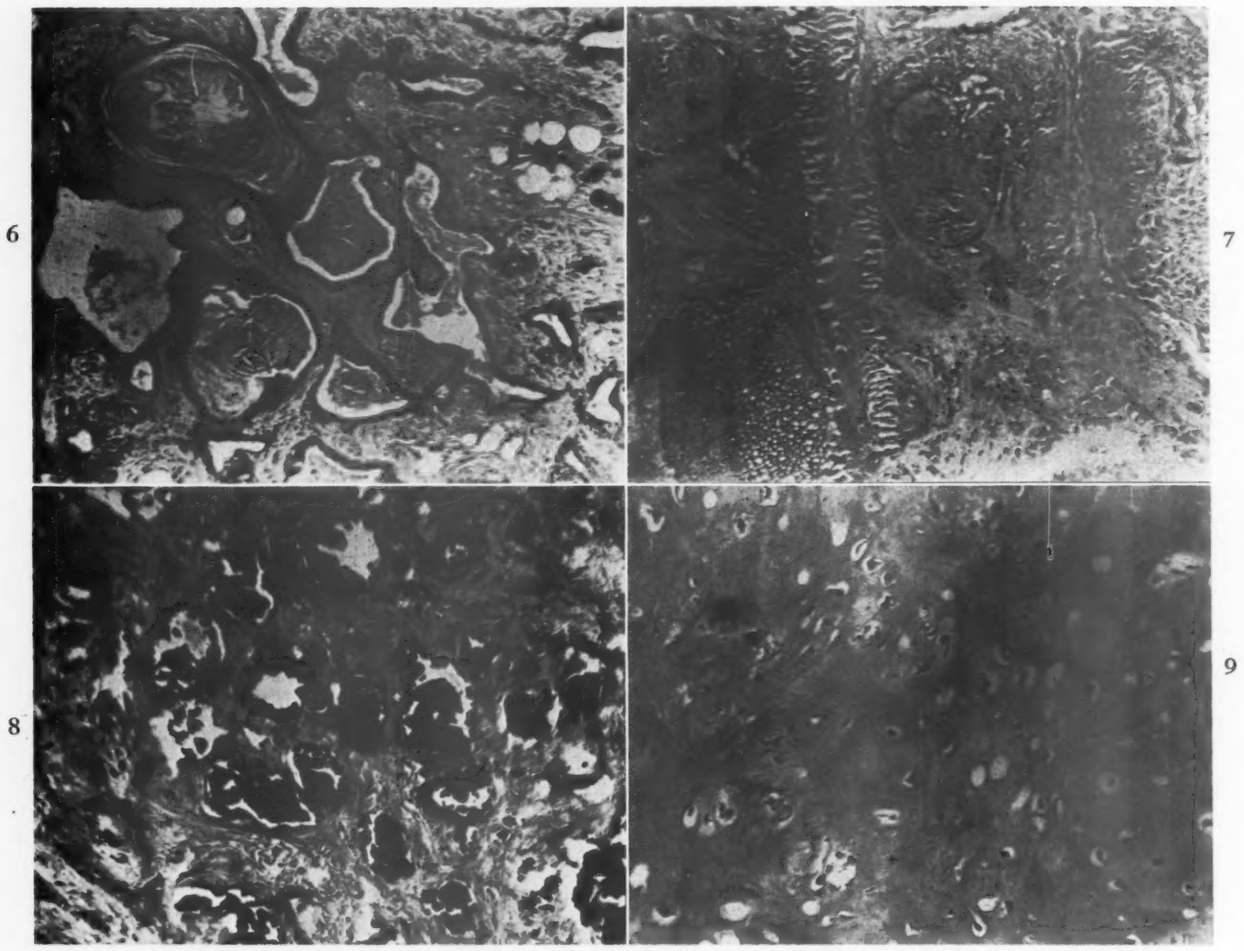

FIG. 6. Low power photomicrograph showing large-sized pearl formation (Ehrlich's hematoxylin and eosin stain).

FIG. 7. Low power photomicrograph showing mucus in epithelial cells and gland lumina (mucicarmine stain).

FIG. 8. Low power photomicrograph showing extensive calcification (Von Kóssa stain).

FIG. 9. Low power photomicrograph showing cartilaginous metaplasia of the stroma (Ehrlich's hematoxylin and eosin stain).

masses were embedded in a loose, myxoid stroma, the cells of which were made up of spindle and stellate cells with large vesicular nuclei surrounded by a very thin layer of cytoplasm. (Figs. 2 and 3.) Squamous cell metaplasia of some of the glandular cells was noteworthy. (Figs. 4 and 5.) Large-sized pearl formation was a prominent feature in three cases. (Fig. 6.) In one of these tumours in which squamous metaplasia was a prominent feature, mucus-secreting cells had been demonstrated by mucicarmine stain. (Fig. 7.) By Von Kóssa stain large deposits of calcium were demonstrated in case No. S 51-89. (Fig. 8.) In case No. S 55-2179, the only case of mixed tumour of the lower lip in our series, the epithelial element was conspicuous by its absence. Pseudocartilaginous pattern was striking. In several fields it closely resembled a hyaline cartilage. (Fig. 9.)

Table II summarizes histologic findings in these tumours.

COMMENTS

Age. In our series the age of the patient varied from twelve to thirty years with an average of twenty-three and a half years. This is relatively lower than Eggers' [4] series in which more than one-half of these tumours occurred in the fourth and fifth decades. In Bernier's [1] series the average age of the patient when first seen was 33.2 years.

Sex. Bernier noticed a marked preponderance of these tumours in males. Thirty-six of

thirty-eight tumours studied by him occurred in men and only two in females. In Eggers' [4] study sex was noted in only forty-three cases. Twenty-four of these occurred in males and nineteen in females. In our series four cases were in males and two in females. In Foote and

TABLE III

Authors	No. of Cases	Tumours from Lips	Per cent
Patey, Zymbal and Harvey et al. [10]	380	15*	4
Willis [11]	48	1	2
Bernier [1]	600	38	6
Present series	50	6	12

* This includes tumours from the lips and other sites.

Frazell's [6] study of 877 cases of mixed tumours from the major and minor salivary glands, 60 per cent were in females. Thus, a marked sex difference is observed in the mixed tumours of the major and minor salivary glands and those occurring at ectopic sites like the lip.

Histogenesis. The origin of mixed salivary tumours from the epithelium is now a well accepted fact. Other views such as origin from the connective tissue, vascular endothelium or the branchial anlage are only of antiquarian interest (Foote and Frazell [6]). Although most authors agree that these tumours arise from adult glandular epithelium in salivary glands, yet the theory of origin from embryonic cell-rests cannot be dismissed summarily. The occurrence of these tumours at the sites of fusion and folding in the complex embryonic development of the face is favourable evidence in support of this concept. Mixed tumours are much more common in the upper than in the lower lip. This disparity in frequency can be explained by the more complex embryologic development of the upper lip. The upper lip is formed in its lateral parts from the maxillary processes whereas its median portion is formed by the lower part of the frontonasal process (Hamilton et al. [7]). (Fig. 10.) The location of mixed tumours on either side of the middle line of the upper lip corresponding to the fusion lines, lends further support to the origin of these tumours from embryonically misplaced tissues. Bernier [1] in his series found only one tumour occurring in the middle line of the upper lip. The lower lip is much simpler in its development and is formed from the free edges of the mandibular processes. This accounts for the rarity of mixed tumours at this site. Even a single case of such a tumour in the lower lip has at times become a subject of

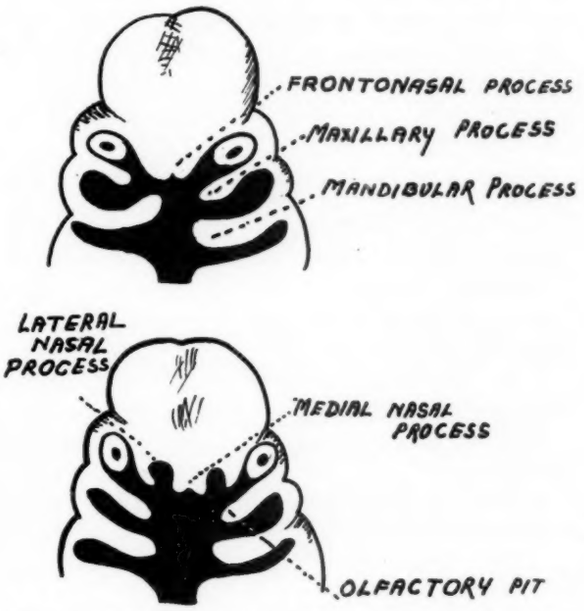

FIG. 10. Diagram showing development of face. Redrawn from: MCGREGOR, A. L. A Synopsis of Surgical Anatomy, 7th ed., p. 346. Bristol, 1950. John Wright & Sons, Ltd.

reporting (Cawley and Wheeler [3]). Bernier is the only author whose series includes three cases from the lower lip.

Frequency. Table III summarizes the frequency of the mixed tumours occurring on the lips as reported by various authors.

Histology. Ewing [5] believes that mixed tumours on the lips are simple histologically and do not duplicate complicated structures of the tumours occurring in major and minor salivary glands. In our study these tumours in no way differed histologically from those occurring in salivary glands. Pseudocartilaginous structures were noted in two (40 per cent) of our cases. This is in keeping with the findings of Eggers [4] and Bernier [1] who found such changes in nearly half of their cases. The squamous metaplasia of the epithelium as noted by Bernier in a large percentage of his cases, was also present in two of our cases. Harrison [9] believes that mixed tumours occur almost entirely within the major and minor salivary glands, whilst the cylindromas arise

most commonly in an ectopic site outside the large salivary glands. According to him cylindromas in ectopic sites are dangerous, liable to recur and metastasize. In our series we did not come across a single case of cylindroma. Bernier believes that perhaps 5 per cent of tumours of the lip can be classified as mucoepidermoid tumours. In our study only one case showing squamous metaplasia of lining epithelium of ducts and increase of mucous cells, can justifiably be grouped under this heading.

SUMMARY

1. Of fifty cases of mixed tumours of the salivary glands studied in the Department of Pathology, Medical College, Nagpur, India, over a period of seven years, six (12 per cent) occurred on the lips.

2. A clinicopathological study of these tumours at ectopic sites is presented.

3. The histogenesis of these tumours is discussed.

4. One of these cases can be classified as mucoepidermoid tumour.

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Scalene Node Biopsy—Clinical Evaluation and Application

SEYMOUR W. SHAPIRO, M.D. AND LOUIS T. PALUMBO, M.D., *Des Moines, Iowa*

From the Department of Surgery, Veterans Administration Hospital, Des Moines, Iowa.

SCALENE node biopsy has been defined as the *en bloc* removal of a triangular area of fatty tissue and contained lymph nodes. This triangle is bounded medially by the internal jugular vein, inferiorly by the subclavian vein and superiolaterally by the inferior belly of the omohyoid muscle. The floor of the triangle is formed by the anterior and medial scalene muscles and the roof by the superficial layer of the deep cervical fascia.

Although involvement of these lymph nodes on the left side has long been recognized in cases of advanced intra-abdominal malignancy (Virchow's node), not until 1949 was it observed that pulmonary lesions, both benign and malignant, might be diagnosed by examination of these lymph nodes. Daniels reported five such cases [4]. Since then, several reports have appeared indicating that in a significant percentage of cases, obscure pulmonary lesions including bronchiogenic carcinoma, sarcoidosis, silicosis, blastomycosis and tuberculosis could be diagnosed by this relatively simple procedure. As would be expected, if the nodes can be palpated clinically, the percentage of positive histologic or bacteriologic diagnoses is quite high.

Scalene node biopsy has been utilized at this hospital as an aid in determining operability on patients with carcinoma of the lung. A report of this experience is presented herein.

RESULTS OF STUDY

In a thirty-month period ending July, 1957, scalene node biopsies (Table I) were performed upon fifty-one patients. Metastatic carcinoma was found in nine (18 per cent) of the cases. Of these fifty-one patients, thirty-eight had proved primary carcinoma of the lung, and in this group, seven (19 per cent) patients showed metastatic carcinoma in the scalene nodes. (Table I.)

The carcinoma was primary in the right lung in nineteen cases and in the lower left lobe in five cases. In this group of twenty-four, right scalene node biopsy was positive in three cases. Of these, two were lesions of the upper right lobe and the third presented as a right hilar mass. In none of the lower lobe lesions or the combined middle and lower lobe lesions were the scalene nodes positive. The carcinoma of the lung was primary in the left upper lobe in eight cases and presented as a left hilar mass in six instances. In this group of fourteen, left scalene node biopsies were positive in four cases; two were lesions of the upper left lobe and two were left hilar masses. (Table II.)

TABLE I
SCALENE NODE BIOPSIES

Total patients	51
Positive right	4
Positive left	5
Total	9 (18%)
Patients with carcinoma of the lung (38)	
Positive right	3
Positive left	4
Total	7 (19%)

Scalene nodes were clinically palpable in six of the thirty-eight patients with primary carcinoma of the lung. In two patients with palpable nodes, carcinoma was not found on microscopic studies.

Of the four patients having positive left scalene node biopsies, three had palpable nodes. Lesions of the upper left lobe accounted for

TABLE II

Site of Primary Tumor	No. of Cases	No. of Positive Biopsies
Biopsy of Right Side		
Right upper lobe	9	2
Right middle and lower lobes	2	0
Right lower lobe	5	0
Right hilum	3	1
Left lower lobe	5	0
Total	14	3
Biopsy of Left Side		
Left upper lobe	8	2
Left hilum	6	2
Total	14	4

two of these and the third lesion was a left hilar mass. Of the three patients having positive right scalene node biopsies, one had clinically palpable nodes and the primary lesion presented as a right hilar mass. There were three patients in whom nodes were not palpable clinically, but metastatic carcinoma was found in the scalene node specimens.

CRITERIA OF OPERABILITY

Demonstration of pleural effusion containing malignant cells, paralysis of the diaphragm or vocal cord, extension of the tumor into the chest wall as shown by bone destruction, or distant metastases were accepted as evidence of inoperability. On this basis, as shown in Table III, half of the thirty-eight patients were considered operable prior to scalene node biopsy. In this group there were two (10 per cent) positive biopsies. In the group of patients without palpable nodes, the nodes were positive in 8.1 per cent. In the group considered inoperable prior to scalene node biopsy there were five (26 per cent) positive biopsies.

TABLE III
DETERMINATION OF OPERABILITY

Prebiopsy	Postbiopsy	
	Negative	Positive
Considered operable (19 cases)	17	2 (10%)
Considered inoperable (19 cases)	14	5 (26%)

TABLE IV
DISPOSITION OF PATIENTS

Inoperable	21	(55%)
Pneumonectomy	6	(21%)
Lobectomy	2	
Exploration	8	
Refused operation	1	
Total	38	

The disposition of the thirty-eight patients with carcinoma of the lung is shown in Table IV. In only eight patients (21 per cent) was pulmonary resection performed. In another eight patients the findings at thoracotomy precluded pulmonary resection. One patient refused operation. The remaining twenty-one patients (55 per cent) were considerable inoperable. If the inoperable group is combined with the group operated upon but not resected, it is found that twenty-nine of the thirty-eight patients (77 per cent) with carcinoma of the lung were not resectable.

As indicated earlier, scalene node biopsy was performed in thirteen patients who did not have carcinoma of the lung. In ten of these, carcinoma of the lung was considered in the differential diagnosis of the pulmonary lesion. Later these pulmonary lesions were shown to be benign. The scalene node biopsies in these ten patients were, of course, negative for cancer. In one patient with carcinoma of the breast and another with a gastric lesion and a left hilar mass, scalene node biopsies showed metastatic carcinoma. The remaining patient in this group of thirteen patients, who did not have primary lung carcinoma, was suspected of having intra-abdominal malignancy. He had palpable scalene nodes but the biopsy was negative.

Over all, forty-eight patients with benign or malignant pulmonary lesions were subjected to scalene node biopsy. There were seven positive biopsies, an incidence of 14 per cent.

COMMENTS

Scalene node biopsy is a relatively simple operation when performed properly by the experienced surgeon. It can be performed under local anesthesia. However, as pointed out by

Foley et al. [5] it is not an operation to be delegated to the intern or the inexperienced junior resident. It is certainly not an office procedure. The two large venous channels forming the medial and inferior boundaries of the triangle to be dissected may, if inadvertently torn, bleed massively. Hemostasis must be accurate if hematomas, reported as the most frequent complication of scalene node biopsy, are to be avoided. This implies careful ligation of the transverse cervical vessels and their tributaries which traverse the tissue to be resected. Care must also be taken to avoid injury to the thoracic duct on the left and the accessory lymphatic duct on the right. Failure to recognize such injury will result in disturbing lymphorrhea. Thoracic duct injury has been reported by others and occurred in two cases in this series. In both, the lymphorrhea ceased spontaneously, but in one of these several weeks elapsed before the drainage stopped. Although fatality has not been reported as a result of scalene node biopsy, it is conceivable that a tear of the subclavian or jugular veins could result in fatal air embolism or massive hemorrhage.

To be of value, the scalene biopsy must not only be adequate, it must be adequately examined. This means that the entire triangle of fat lying anterior to the scalene muscles and between the jugular and subclavian veins and inferior belly of the omohyoid must be removed. Connar [2] has stated that the specimen should contain at least four lymph nodes. Adequate examination of these nodes requires an interested department of pathology willing to make multiple sections.

In this series, concerned primarily with lung carcinoma, scalene node biopsy seemed valuable as an aid in determining curability. Positive scalene node biopsies were obtained in 26 per cent of patients judged inoperable before biopsy, thus giving additional evidence to support the contention of incurability by surgical means. In the group of patients thought operable before scalene node biopsy, 10 per cent were found to have positive nodes, testifying to their incurability by surgery. Although a positive scalene node biopsy is not considered an absolute contraindication to pulmonary resection, it does demand careful appraisal of the individual case and in many instances will save the patient thoracotomy and thereby reduce the incidence of morbidity and mortality. Extension of the standard scalene node biopsy to include paratracheal mediastinal nodes as reported by Harken et al. [6] will, of course, yield a higher percentage of positive biopsies. This is, of course, a more extensive procedure.

When nodes are palpable in the scalene area, the percentage of positive biopsies is high. However, clinically, palpable nodes are not synonymous with metastatic carcinoma, as demonstrated by the two patients in this series whose palpable nodes contained no demonstrable neoplasm. If nodes are palpable on one side, it is best to perform a biopsy of these regardless of the site of the pulmonary lesion. When nodes are not palpable, the site of the primary lesion governs the choice of the side of the scalene biopsy, based on the pulmonary lymphatic drainage. Thus, lesions of the right lung and lower left lobe will usually drain to the right scalene nodes, while lesions of the upper left lobe drain to the left scalene nodes. Lingular lesions and perhaps those in the superior portion of the lower left lobe may drain to either side so that bilateral scalene node biopsy may be required. It should be remembered that the usual lymphatic route may on occasion be blocked, resulting in drainage to the other side.

Although this study was not concerned with inflammatory lung lesions, scalene node biopsy is useful in these diseases also. Thoracotomy is avoided in many such instances. It is important to study the specimen bacteriologically in these inflammatory conditions.

SUMMARY

Scalene node biopsy is an additional adjunct to the establishment of a diagnosis in many lesions and an important aid in the determination and selection of patients with pulmonary lesions for thoracotomy.

The incidence of positive nodes in proved cases of primary pulmonary carcinoma was 19 per cent in our series. In the instances of non-palpable scalene nodes, the incidence was 8.1 per cent. In a group of patients with pulmonary carcinoma who were considered clinically operable, the scalene node biopsy was positive in 10 per cent. This factor may be an important consideration in selection of patients for exploration and resectability.

A properly performed scalene node biopsy should become a definite part of the over-all

work-up and evaluation of patients with pulmonary lesions, particularly those with primary carcinoma.

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"John Fleet is recognized historically for having been the first to receive a medical degree from Harvard, and for having been one of the founders of the Medical Improvement Society (1803), which society grew into the first Boston Medical Library (July 1, 1805). He was born in Boston, April 29, 1766. . . . [He was] graduated from Harvard College in 1785 at the age of nineteen years. Following his graduation he studied medicine in the Medical Institution of Harvard College. He dissected under Dr. John Warren. Prior to 1788 no medical degree had been granted by the College. In that year, however, John Fleet and George Holmes Hall applied for degrees. These were granted on July 16, but only after a heated professorial discussion. The degree was that of Bachelor of Medicine. As Fleet's name came first alphabetically, he was thus the first to receive a medical degree from Harvard. Seven years later (1795) Fleet was the first to receive the degree of Doctor of Medicine from the College. To get the degree he passed an examination and presented a thesis in Latin, 'Observationes ad Chirurgiae Operationes Pertinentes.' . . . A copy of this is in the Boston Medical Library. Fleet was the first assistant appointed in the Medical Department of Harvard College (assistant to Dr. John Warren, 1793). His friends were the best medical men of Boston. He was one of the prominent founders of the Medical Improvement Society from which grew the Boston Medical Library. Fleet was the first librarian. In the beginning the books were kept at his house in Milk Street. Fleet, also, was librarian of the Massachusetts Medical Society from 1800 to 1813. John Fleet never married. He died in Boston in his forty-seventh year, on January 4, 1813." (T. S. W., *Am. J. Surg.*, 17: 286, 1932.)

The Surgical Management of Massive Melena

LeRoy H. Stahlgren, M.D. and L. Kraeer Ferguson, M.D., *Philadelphia, Pennsylvania*

The surgical management of massive melena often presents a difficult problem because melena may be a clinical sign of either upper or lower gastrointestinal bleeding. When it is associated with hematemesis its source is almost always proximal to the ligament of Treitz. When it occurs without hematemesis or other clinical evidence of blood in the stomach, it may arise anywhere between the esophagus and rectum. Whether massive melena without hematemesis arises more commonly from the upper or from the lower gastrointestinal tract has not been determined.

MELENA FROM UPPER GASTROINTESTINAL LESIONS

Those patients in whom the history, physical examination and x-ray findings establish a cause of melena are not often a major problem in surgical treatment. Their treatment will vary with the disease. Lesions in the upper gastrointestinal tract can frequently be demonstrated by careful x-ray examination. These include gastric and duodenal ulcers, gastric neoplasms and esophageal varices. In our experience, however, when the hemorrhage from such lesions is massive, hematemesis or other clinical evidence of blood in the stomach is usually associated. Therefore, in the presence of melena alone, surgical intervention will frequently not be necessary to control the bleeding from known upper gastrointestinal lesions. The management of massive upper gastrointestinal hemorrhage need not then be considered within the scope of this discussion [*3*].

However, the frequency with which massive melena of obscure origin is caused by nondetectable, acute, shallow gastric ulcers is controversial. Some authors believe that this is a frequent occurrence [*21*]. The fact that these lesions may cause bloody bowel evacuations indicates the need for a meticulous search of the upper gastrointestinal tract in all suspected instances of lower gastrointestinal bleeding.

MELENA FROM LESIONS WHICH CAN BE DIAGNOSED PREOPERATIVELY

The most common lesions in the lower gastrointestinal tract which cause bleeding and can be diagnosed clinically are certain neoplasms and inflammations.

A significant percentage of small bowel tumors are associated with severe melena [*12,18*]. Because of their rarity, however, the diagnosis is frequently missed despite recurrent episodes of bleeding. Careful barium x-ray examination may fail to demonstrate these tumors because they are often intramural or extraluminal in location. The most common tumors of this type are leiomyomas, fibromas, fibromyomas, fibroadenomas [*18*] and those arising from neurogenic elements. The most common intraluminal tumors which bleed massively are the vascular tumors [*18*]. These are usually too small to be seen on x-ray.

Exhaustive x-ray examinations are necessary to establish the presence of small bowel neoplasms. A brief case history follows of a patient in whom the cause for massive melena was demonstrated only after repeated x-ray studies.

G. P., a forty-seven year old white man, was admitted to the Graduate Hospital on April 19, 1955, with bleeding from the bowel. He had been admitted twice previously because of moderately severe melena. A diagnosis of upper gastrointestinal bleeding was made on the equivocal x-ray findings of a duodenal ulcer on each of his previous admissions.

The bleeding began the day before admission and consisted of several tarry stools. An upper gastrointestinal x-ray examination was again suggestive of a duodenal ulcer but in addition a small tumor of the proximal jejunum was demonstrated. (Fig. 1.) At laparotomy a tumor which measured

FIG. 1. X-ray demonstrates a filling defect (arrow) produced by a leiomyoma of the jejunum.

FIG. 2. Serosal surface of the leiomyoma demonstrated in Figure 1.

2 cm. in diameter was found and resected from the proximal jejunum. (Fig. 2.) The duodenum was normal. Convalescence was uneventful and there has been no further bleeding. Microscopic sections revealed a leiomyoma of the jejunum.

Comment: This case emphasizes the importance of thorough and repeated x-ray examination in patients with recurrent episodes of melena. A diagnosis of bleeding duodenal ulcer is frequently incorrectly made in patients with small bowel tumors [*23*].

The most common malignant tumors of the small intestine which cause massive melena are lymphosarcomas and adenocarcinomas [*11*, *12*]. Large intestinal neoplasms (adenomatous polyps, adenocarcinomas) frequently cause a lesser degree of bleeding sufficient to produce anemia but relatively rarely cause massive melena [*16*,*21*]. The diagnosis is usually made on sigmoidoscopic and barium x-ray examination. Their surgical treatment is fairly well standardized and will not be reviewed.

Inflammatory lesions of the small intestine such as regional ileitis rarely cause massive rectal bleeding [*12*]. On the other hand, severe rectal bleeding does occur in far advanced ulcerative colitis and diverticulitis [*4*,*14*,*29*]. The diagnosis can usually be established by history, physical examination and x-ray study. The most common indications for surgery in these diseases include the complications of obstruction, perforation, fistula formation and intractability, but on occasion massive hemorrhage may demand surgical therapy.

MELENA FROM LESIONS WHICH CAN BE DIAGNOSED AT OPERATION

It is difficult to make rules for the selection of those few patients who will require operation. The decision becomes most difficult when the history and physical and radiologic examinations have failed to reveal the nature or the location of the bleeding lesion. Operation is advised for this group if the hemorrhage is exsanguinating, persistent or repeatedly recurring.

Laparotomy should be considered as a diagnostic test when the diagnosis cannot be made by the usual methods before the bleeding recurs too many times. It may be fatal to delay laparotomy because a diagnosis has not been established. In this manner, Meckel's diverticula, extramural small bowel tumors, etc. are found at operation by careful inspection and palpation of the gastrointestinal tract.

Bleeding from a Meckel's diverticulum is actually caused by a peptic ulceration of the adjacent ileal mucosa due to the presence of ectopic gastric mucosa in the diverticulum [*5*]. Its presence should be suspected preoperatively in children and young adults with massive melena but the diagnosis must be established at laparotomy. It should be distinguished from the non-meckelian diverticula which occur in the small intestine and occasionally cause massive bleeding [*9*].

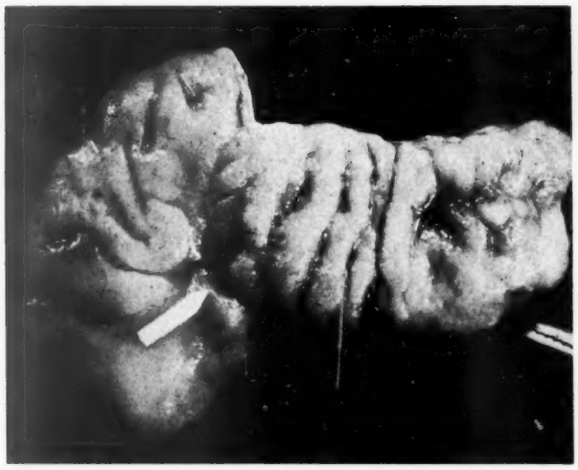

FIG. 3. Ulceration of the ileal mucosa at the base of a Meckel's diverticulum.

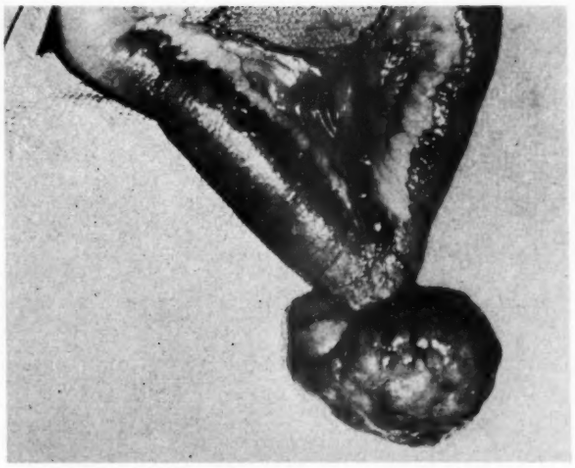

FIG. 4. Neurofibroma of the ileum demonstrating its extraluminal position and rich blood supply.

The following case history illustrates massive bleeding from a Meckel's diverticulum.

R. D., a nine year old white boy, was admitted to the Graduate Hospital on November 29, 1950, with massive currant jelly–like melena and intermittent left and mid-abdominal pain. Laparotomy revealed a Meckel's diverticulum with bleeding ileal ulceration. (Fig. 3.) Following resection, convalescence was uneventful.

Comment: Laparotomy was indicated in this case because of continuing massive rectal bleeding. The diverticulum was easily discovered on inspection of the small intestine. The abdominal pain was probably caused by the ileal ulceration and is not an uncommon finding.

Another case history follows in which the diagnosis had been unknown preoperatively but was established at laparotomy.

M. B., a fifty-one year old Negro woman, was admitted to the Graduate Hospital on April 6, 1955, complaining of weakness and dyspnea.

She had been studied unsuccessfully at another hospital six years before for severe iron deficiency anemia. Gastrointestinal x-rays failed to reveal a source for the blood loss. Six months before this admission the anemia was again investigated. The hemoglobin was 4 gm. per cent. Despite the presence of gross blood in the stools gastrointestinal x-rays were negative for abnormalities. Unfortunately, she suffered an acute myocardial infarction during that admission. The chronic anemia no doubt contributed to the cardiac complication.

On the present admission, the hemoglobin was 6 gm. per cent and the red blood cell count was 2.4 million per cu. mm. The stool contained 4 plus occult blood.

Careful upper and lower gastrointestinal x-rays again were normal. While further examinations were being planned, she went into shock due to the sudden onset of massive melena. The stool contained bright red and tarry blood. It was believed that diagnostic laparotomy was indicated because of the massive nature of the melena and the repeated failure to reach a diagnosis clinically.

At operation a 4 by 5 cm. extramural tumor was found arising from the terminal ileum. (Fig. 4.) The intraluminal blood extended 12 inches above the tumor. The loop of intestine containing the mass was resected. Convalescence was uneventful and there has been no further bleeding.

Microscopic sections revealed a neurofibroma of the ileum.

Comment: This patient exhibited persistent melena which required operation when the hemorrhage became massive. The source of the bleeding was easily found at operation by inspection of the small intestine. The neoplasm had not been demonstrated preoperatively by x-ray because it was mainly extramural in location.

MELENA FROM LESIONS WHICH CANNOT BE DIAGNOSED AT OPERATION

In some instances the diagnosis will be obscure even after the most careful intra-abdominal exploration. The best way to find such obscure lesions is to operate while the bleeding is active [*1,16*]. This gives the surgeon a good chance to find the lesion even if it is too small to see or feel. In our experience such in-

conspicuous lesions as small vascular tumors, eroded arteriosclerotic vessels, etc. frequently cause the most massive blood loss. If the intestine is opened at the most proximal point where blood is found the lesion may be discovered and may, in fact, be seen actively spurting. This observation is particularly helpful in the small intestine where the level of intraluminal blood rarely rises more than 12 inches above the bleeding lesion. Massive bleeding in the colon will probably fill the intestine as far as the ileocecal valve, so that the level of blood in the colon may not have the same significance.

If the bleeding from an obscure lesion has temporarily stopped, the blood may be rapidly evacuated from the involved segment of intestine, and hence the level of the blood in the intestinal tract may give no clue to the location of the lesion. In that situation multiple incisions are made into the intestinal lumen and the mucosa is examined as carefully as possible. This is more difficult than it sounds because the operator may find the terminal ileum and colon filled with dark, sticky blood and may fail to locate the source of hemorrhage despite a meticulous search. We believe that the sigmoidoscope is useless in such instances. We choose, instead, to grasp the intestinal mucosa through the incision in the bowel wall and intussuscept it through the opening. In this manner the mucosa may be examined for a distance of 8 to 10 inches on either side of the incision. Multiple enterotomies and colotomies may be necessary to examine the involved gut. It should be re-emphasized that the upper gastrointestinal tract must also be thoroughly examined in these obscure cases.

If, after thorough exploration, no discrete lesion can be found but diverticula are present these should be considered a possible source of hemorrhage [*7,8,16,25*], despite the fact that diverticular disease has not been definitely established as a common cause of massive melena [*4,7,8,12,29*]. A number of authors have reported that the two have coexisted in the absence of any other apparent cause for bleeding [*2,7,8,14,16,20,21,27,29*]. This, however, does not prove that the diverticula have actually caused the bleeding in those patients. Nevertheless, there is clinical evidence that diverticula do occasionally cause bleeding [*6,7,* 30]. Blood has been seen and reported as coming from a colonic diverticulum [*10*].

There is also theoretical support to this cause and effect relationship between diverticula and bleeding. In the development of a diverticulum the intestinal mucosa is thought to herniate through a weak point in the bowel wall created by the penetration of a blood vessel. This relationship to a blood vessel probably accounts for the rich blood supply of diverticula and the brisk hemorrhage which can occur [*14*]. Trauma and erosion of the mucosa in a diverticulum may occur due to pressure of fecal debris. The resultant granulation tissue and ulceration may be the site of bleeding. In the examination of surgical and autopsy specimens in patients with melena and coincidental diverticular disease there have been instances when diverticula were found to contain mucosal erosions which could have bled [*7*]. In other cases complete inversion of a diverticulum into the intestinal lumen has occurred with resultant ulceration of the mucosa of the diverticulum [*30*].

Despite this evidence, however, massive melena has been attributed to diverticular disease mainly by exclusion. Whether there are coexisting undetected vascular or other mucosal lesions more commonly causing the bleeding remains to be seen.

It is interesting that many of these patients are elderly and hypertensive. In many of these older patients with vascular disease involving the larger vessels (aneurysm, atheromatous changes), we believe that the bleeding more commonly arises from vascular disease of the intestinal vessels [*15,28*] than from diverticula. These vessels escape detection unless observed while actively bleeding. Such bleeding points have been seen and reported [*1,17*].

Because of the occasional evidence that diverticular disease does cause massive hemorrhage, we recommend its resection when the disease is localized and when no other apparent source of bleeding can be found despite a careful examination of the upper and lower gastrointestinal tract. When the diverticular disease is diffusely spread throughout the colon in the absence of any other lesion colectomy and ileosigmoidostomy may have to be performed to control truly exsanguinating hemorrhages. A case history will be briefly described to illustrate this problem.

M. D., a seventy-seven year old white man, was transferred to the Woman's Medical College Hospital on April 26, 1955, because of massive melena of four days' duration. After admission the bleeding continued intermittently for six days. Each exacer-

bation of blood loss was accompanied by clinical shock despite vigorous blood replacement.

During this time there was no hematemesis nor was blood obtained from the stomach on gastric suction. The blood coagulation mechanism was found to be normal.

Because of the exsanguinating nature of the melena, emergency laparotomy was performed on May 2, 1955. The colon was filled with clotted blood but no blood was found proximal to the ileocecal valve. There were multiple colonic diverticula from the cecum to the sigmoid and all contained blood. The stomach, duodenum and small intestine were carefully inspected but no lesion was discovered. An aortic aneurysm was present. Multiple colotomies were performed and the colonic mucosa was intussuscepted into the incisions and meticulously inspected without finding the bleeding point.

Despite these negative findings colectomy was performed with end-to-end ileosigmoidostomy. The postoperative course was uneventful.

The pathologists were unable to find a lesion in the resected specimen to explain the bleeding. They reported diffuse diverticulosis without inflammation or ulceration of the mucosa.

The patient died from rupture of the aortic aneurysm eighteen months later without a recurrence of the gastrointestinal hemorrhage in the interim.

Comment: The cause for the melena was not discovered at operation but because of the exsanguinating nature of the hemorrhage and the presence of diffuse diverticulosis colectomy was performed as a life-saving measure. The operation apparently controlled the bleeding. Although the bleeding point was not detected after careful examination of the resected colon in the pathology laboratory, it is possible that the bleeding arose from a diverticulum or from a ruptured sclerotic submucosal vessel. In either situation the bleeding point could escape detection.

Occasionally the surgeon may be asked to operate when there have been repeated bouts of melena recurring over a period of years, and despite exhaustive studies the cause for the bleeding remains undiscovered. In these patients laparotomy must be performed while the bleeding is active. Patients who are seen between episodes of melena or whose bleeding has stopped during study are discharged from the hospital with instructions to return immediately when the melena recurs [1]. On readmission exploratory laparotomy is promptly performed without wasting time repeating studies. This technic will often lead to the diagnosis of the bleeding lesion. An illustrative case history follows.

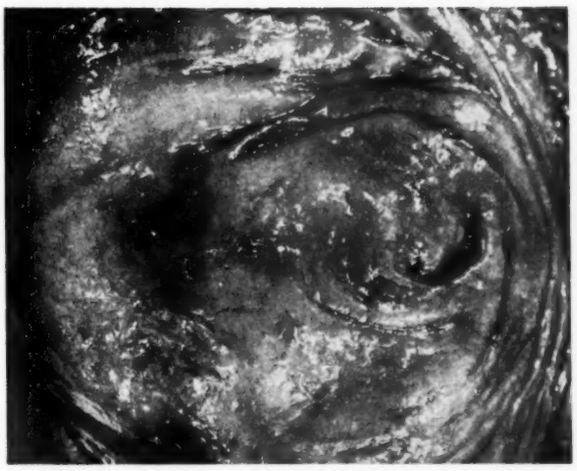

FIG. 5. Telangiectasia of the cecum. The ileocecal valve is at the right.

B. H., a forty year old white woman, was admitted to the Graduate Hospital on June 23, 1953, with massive melena beginning two hours before admission. She had been unsuccessfully studied during a previous bleeding episode and told to report immediately upon the recurrence of bleeding.

Rectal bleeding began eight years before following an abdominal hysterectomy. She was hospitalized and studied without diagnosis and discharged after the bleeding had stopped. She noted occasional coating of the feces with red blood for the next two years when she again experienced a massive rectal hemorrhage. After several transfusions she was operated upon at another hospital with negative findings. Occasional minimal gross bleeding again occurred with bowel movements until two and a half years before this admission when massive melena recurred. Seven transfusions were needed to replace the blood loss. Exhaustive studies including barium x-rays were non-revealing. She was discharged without a definitive diagnosis. Repeated x-rays were negative for abnormalities over the next two years. Occasional red blood appeared with bowel movements.

The evening of admission she noted cramping abdominal pain followed by the passage of a large amount of red blood. She had also noted some periumbilical discomfort four or five days before admission. Examination revealed slight hypotension (96/52 mm. Hg) with moderate tachycardia (92 beats per minute). There were no melanin spots about the buccal mucosa and no evidence of telangiectasia.

Abdominal examination revealed slight tenderness to the right of the umbilicus. Sigmoidoscopy to 7 inches revealed red blood clots coming from

above the end of the scope. There were no mucosal lesions or hemorrhoids.

She was operated upon the next day. At laparotomy blood filled the entire colon and distal 12 inches of ileum. Careful exploration of the small bowel revealed no lesion. Multiple colotomies were performed resulting in the discovery of a spurting vessel in the cecum. Resection of the cecum was performed. Convalescence was uneventful and there has been no further bleeding.

The pathologic diagnosis was telangiectasia of the cecum. (Fig. 5.)

Comment: The only way that this minute lesion could be found was to operate while the bleeding was active. Such vascular lesions may be more commonly found as a cause of massive melena [*22,24*].

SUMMARY

When melena is associated with hematemesis its source is usually proximal to the ligament of Treitz. When melena occurs alone the bleeding may arise anywhere from the esophagus to the rectum. Operation is advised when the melena is obviously exsanguinating, persistent or repeatedly recurring. Many of the lesions causing melena can be diagnosed clinically. Their treatment will depend on the nature of the disease. In other patients a diagnosis cannot be made by the usual methods. In this group we advise diagnostic laparotomy while the bleeding is active, before the bleeding recurs too many times. In this manner bleeding Meckel's diverticula, extramural small bowel neoplasms, etc. may be discovered. If a lesion cannot be found, the highest level of intraluminal blood may serve as a guide to the bleeding point. Multiple enterotomies and colotomies are performed and the adjacent mucosa is intussuscepted into the opening in the bowel wall. If still no lesion is found, intestine containing obvious disease such as diverticulosis is resected. We believe, however, that in many elderly patients with sclerotic vessels the bleeding arises from rupture of an intestinal submucosal artery rather than from the coincidental diverticular disease.

Illustrative case histories are included.

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"'The Father of American Surgery,' Philip Syng Physick, was born in Philadelphia on the 7th of July, 1768. . . . As the Physicks lived in the country, seven miles out of Philadelphia, Philip was introduced as a boarder in the family of Mr. John Todd, father-in-law of the lady who, as Widow Todd, became the wife of James Madison, afterwards President of the United States. Philip was placed under the care of the historian, Robert Proud. From the academy he was transferred to the classical department of the University of Pennsylvania, where in 1785 he took his A.B. degree. After a month's rest Physick entered the office of Dr. Adam Kuhn, then Professor of Materia Medica and Botany in the Philadelphia College of Medicine. He remained with Dr. Kuhn three and a half years. He did not take his degree but went abroad (1789) and studied under John Hunter. He became a member of Hunter's family. He was selected as house-surgeon to St. George's Hospital for one year. Physick remained under Mr. Hunter's care for two years and four months. Hunter invited Physick to take up his residence with him and to share his professional burdens, what most people of that time would have considered an enticing opportunity. However, Physick went to Edinburgh, after receiving his license from the Royal College of Surgeons (1791), and received his medical degree in May, 1792. . . . In 1794 he became surgeon to the Pennsylvania Hospital, and professor of Surgery in the University of Pennsylvania (1805–18). With all his brilliancy and training he wrote nothing of great note. He introduced absorbable kid and buckskin ligatures, the use of the seton in ununited fracture, an operation for artificial anus, rest in hip-joint disease, and the invention of the tonsillotome. It is said he was the first to describe diverticula of the rectum, and the first American to wash out the stomach in cases of poisoning. His reputation spread to all parts of his country and abroad. He had one of the largest and most remunerative surgical practices of his day. Philip Syng Physick expired on December 15, 1837." (T. S. W., *Am. J. Surg.*, 15: 381, 1932.)

The Colostomy Case—Norms and Deviations

LESTER BREIDENBACH, M.D. AND SOPHIA M. SECOR, M.A., *New York, New York*

WHEN a colostomy patient is first approached with new instructions on how to carry on his life as he did before surgery, he must be advised of the norms that fit the great majority of cases. It is true that there may be deviations from the norm according to the needs of the individual patient, but these are better dealt with later, when the patient is ready to face them. The patient is confused and bewildered at this time. He needs reassurance and encouragement, and a positive approach. Any temporizing or vacillating during this trying period will put the patient into a state of renewed panic and deeper depression.

One of the authors has been a colostomy patient for the past ten years, and the first five were spent in experimentation and finding her own norms. Since that time, rehabilitation technics have been undertaken with 400 colostomy patients of eminent surgeons. Rehabilitation is begun early—usually a day or two after the sutures are removed. The job at hand is to enable the patient to face the future with a hopeful outlook and with a definite knowledge of the methods involved in caring for the colostomy. The earlier the rehabilitation is undertaken, the faster and more satisfactory is the complete recovery of the patient.

There is no question as to what will be told to the patient. With a sympathetic attitude and an understanding approach, the patient must learn as soon as possible how to take proper care of his colostomy. He is never told that there are individual differences that may have to be met and solved later. He is told, rather, that his colostomy problems are the responsibility of the surgeon and that any problems which may present themselves will be solved as they occur. The patient longs for someone to lean on and from whom he may receive definite, detailed instructions on how to continue life in the way he did before surgery.

In the 400 colostomy cases that were studied intensively during the past five years, we have found that there is a definite norm from which there may be only slight deviations on either side to allow for individual differences. After the method of care is clearly explained (usually the nurse and a member of the family are present), the patient keeps in touch with the rehabilitation worker every twenty-four hours. When he tells how his colon has behaved in the past twenty-four hours, he can then be advised what to do and how to proceed for the next twenty-four hours. He is greatly encouraged when he sees that the instructions work. He always feels that since others have been able to manage successfully, he can also.

The norm that every colostomy patient must reach in order to be completely rehabilitated is a *forty-eight-hour period of freedom from spillage between irrigations without wearing a bag.* This objective may be reached by various means, depending on individual differences and attitudes within the patients themselves. It is up to the doctor to be acquainted with the norms, as well as with his individual patient, and to bring his patient toward his own norm as soon as possible.

The knowledge that he has a colostomy puts the patient into a state of deep depression for about six months after surgery. The loss of sphincter control and its implied loss of social contacts looms in the beginning as a frightening experience and an insurmountable problem. About 90 per cent of these patients do not know about their colostomy until well after surgery; and yet, on questioning, 90 per cent of the patients indicate that they would have preferred being told prior to surgery.

Of our 400 cases, 175 patients (43.75 per cent) were men and 225 (56.25 per cent) were women. (Fig. 1.) The ages of the patients are summarized in Figure 2.

The occupations of the men were as follows: unskilled laborer, thirty-two (18 per cent);

white collar worker, forty-two (24 per cent); self-employed, sixty-six (38 per cent); professional, thirty-five (20 per cent). One hundred fifteen (51 per cent) of the women were housewives, sixty-eight (30 per cent) were white

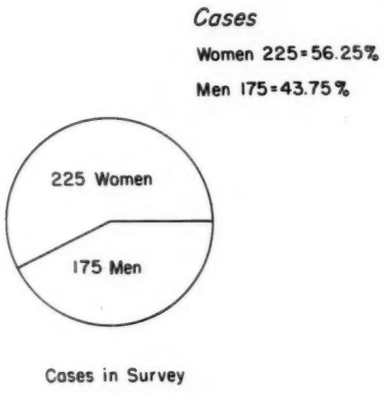

FIG. 1.

collar workers, and forty-two (19 per cent) were professionals.

The *height of the irrigating can* is one of the most important facts to be learned in the rehabilitation process. (Fig. 3.) We measure the bottom of the can in relation to shoulder level. The norm as we see it is 4½ inches below shoulder level. (Table 1.)

TABLE 1

Level	Patients	
	No.	%
At shoulder	10	2.5
1 inch below shoulder	20	5.0
2 inches below shoulder	30	7.5
3 inches below shoulder	40	10.0
4 inches below shoulder	50	12.5
4½ inches below shoulder	225	56.2
5 inches below shoulder	20	5.0
5½ inches below shoulder	5	1.2

Experiments have shown that if the can is held too low the water pressure will be insufficient for the water to enter the colon. If the can is held higher than these levels, the water will rise into the transverse colon and will remain there for a period of about twelve to twenty hours and then come out in spurts during this time. With the can at this height the colon will *not* be emptied properly since the water has dispersed to the entire colon and *not* to the descending colon where water should build up pressure. We have experimental x-ray films showing that water will rise only in the descending colon if the can is held low. Otherwise the water will go elsewhere in the colon.

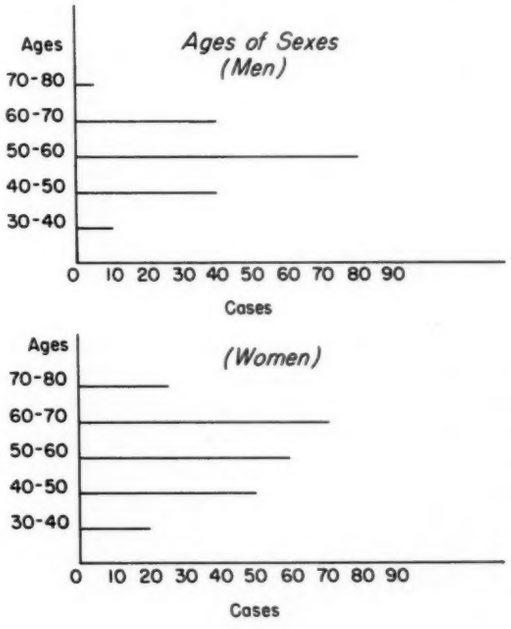

FIG. 2.

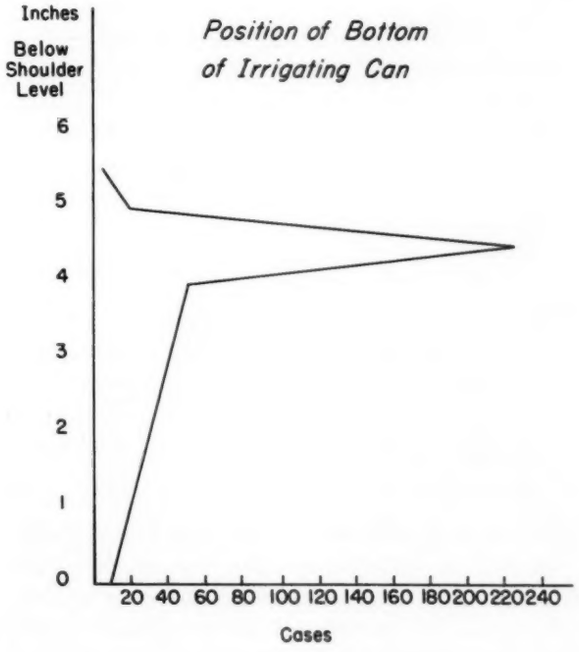

FIG. 3.

It has been a mistaken idea of most physicians that the irrigating can should be held from 18 to 24 inches above the colostomy. This

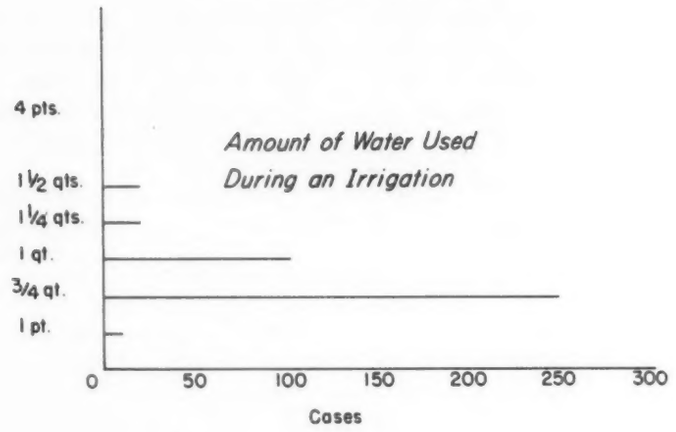

FIG. 4.

idea is quite prevalent. However, the patient will never reach a stage of freedom from spillage if the can is held at these levels. Six inches above the colostomy, or 32 inches from the floor while the patient is sitting, is nearer the correct height. The equivalent of these levels is approximately 4½ inches below shoulder level. The proper height of the can, therefore, can be established at about 4½ inches below shoulder level and can be safely used as a norm. Deviations might involve ½ or 1 inch or so either way.

The normal *amount of water to be used* (Fig. 4, Table II) is somewhere between ¾ and 1 quart.

TABLE II

Amount (qt.)	Patients	
	No.	%
½	10	2.5
¾	250	62.5
1	100	25.0
1¼	20	5.0
1½	20	5.0

This norm should be started with the patient. The use of less water than ½ quart would simply cause the fecal matter to be somewhat moistened but would not cause sufficient pressure for satisfactory emptying. The patient will get seepage and will feel generally uncomfortable. The use of more water than 1½ quarts would not be possible when the irrigating can is held at the low level of 6 inches above the

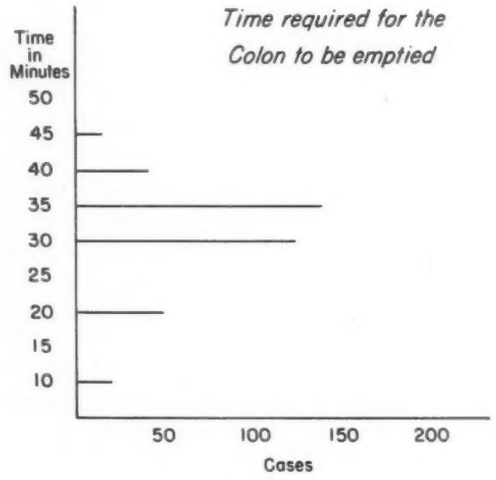

FIG. 5.

colostomy. However, some patients might attempt a second irrigation if the first is unsuccessful (probably because of constipation). Here again it would not be advisable to try a second irrigation. The colon might become waterlogged and seepage might occur. Usually, if

TABLE III

Time (min.)	Patients	
	No.	%
10	25	6.2
20	50	12.5
30	125	31.2
35	140	35.0
40	45	11.2
45	15	3.7

the colon is sluggish and the fecal matter hard, other steps will have to be taken to remedy this condition. This will be discussed later.

The *normal length of time for the colon to be emptied* is thirty to thirty-five minutes. (Fig. 5, Table III.)

The *water usually enters the colon* in ten minutes. (Fig. 6, Table IV.)

TABLE IV

Time (min.)	Patients	
	No.	%
5	10	2.5
6	12	3.0
7	25	6.2
8	33	8.2
9	60	15.0
10	125	31.2
11	50	12.5
12	40	10.0
13	30	7.5
14	10	2.5
15	5	1.2

Temperature of the Water. The majority of physicians have stated that the temperature should be 105°F. We have found in all the cases that the temperature should be nearer 80°F. Tepid and very lukewarm water will cause movement to start much more quickly than water at a higher temperature. We use no solution in the water.

The Size of the Catheter. In 99 per cent of all cases the size most effective is No. 24 F. A very small number of patients had to use No. 18 F., 20 F. or 22 F. if the colon was constricted or narrowed down in any way. The walls of the colon will sufficiently hug the No. 24 F. catheter so that very little water escapes from the colon. Any amount of water that may escape is not considered part of the water entering the colon.

Insertion of Catheter. The catheter should be inserted *all the way* in nearly 100 per cent of the cases for satisfactory emptying. Some physicians believe that the catheter should be inserted anywhere from 3 to 6 inches. This distance will not build up sufficient pressure behind the solid fecal matter to empty the descending colon properly. Some think that there is danger of perforation if the catheter is inserted too far. Experimental x-ray films showing the introduction of the entire catheter revealed that the tip of the catheter was about 2 inches away from the splenic flexure. In cases of a shorter descending colon it was shown that the catheter simply curled up in the

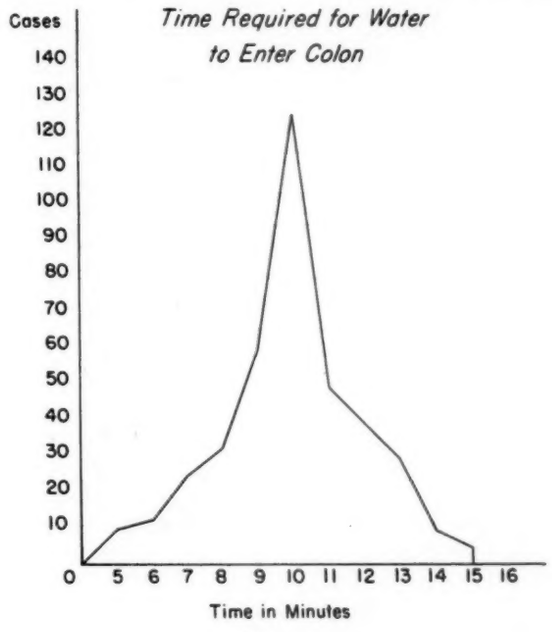

FIG. 6.

descending colon. At no time did the catheter move into the transverse colon.

How often is it necessary to irrigate the colon? We have found the norm to be once in every forty-eight hours. (Table V.)

TABLE V

Time	Patients	
	No.	%
Once a week	2	0.5
Twice a week	5	1.2
Every 72 hr	25	6.2
Every 48 hr	292	73.0
Every 24 hr	75	18.8
Not at all	1	0.2

The one patient who claimed she did not have to irrigate said that her colon would empty itself immediately after breakfast. However, if she "ate food that did not agree" with her, she would then have to irrigate.

Although two other patients claimed that they did not need to irrigate, we learned that

one wore a bag and the other changed dressings numerous times during the day. We asked all the patients to try the non-irrigating method to see if the colon would empty itself naturally. We found that in not one of the cases could this be accomplished.

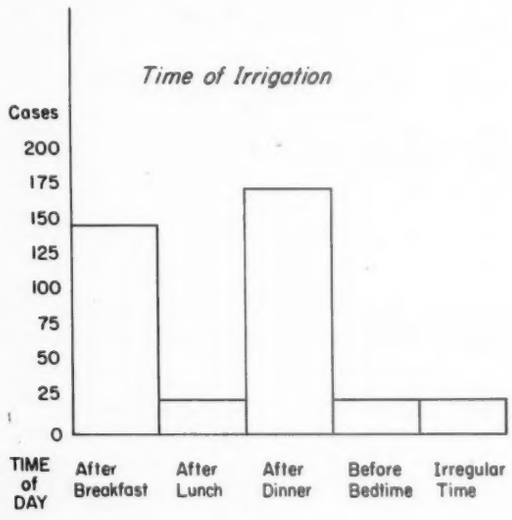

FIG. 7.

The non-irrigating method was tried as an experiment in over 100 cases, but the patients found it most uncomfortable. Those who tried it had to avoid social contacts during the experiment. This method was found to be unsuccessful in all these cases.

In Figure 7 and Table VI we have charted data on the *time to irrigate*.

TABLE VI

Time	Patients	
	No.	%
After breakfast	150	37.5
After lunch	25	6.2
After dinner	175	43.7
Before bedtime	25	6.2
Irregular times	25	6.2

The norm here may be either after breakfast or after dinner. We advised those patients who did not have to go to work to irrigate after breakfast. For those who work it is better to irrigate after dinner. In that way the patient has the entire evening in which to relax. Neither does he have to worry too much if the colon does not empty itself properly, as may happen when the patient is constipated.

There were a few patients who simply would not irrigate at regular times. A few hours may not make a difference, but a day might cause spillage.

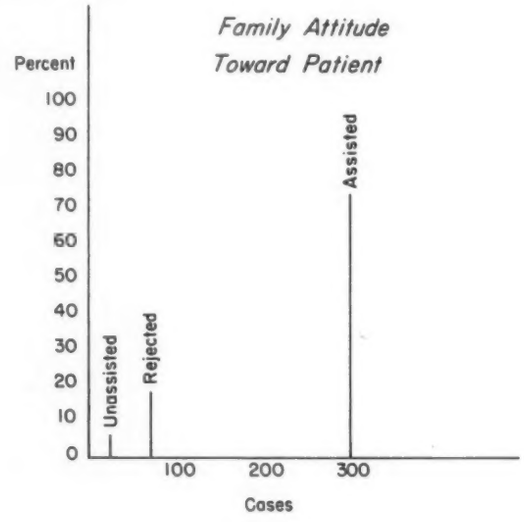

FIG. 8.

Family Relationships after Surgery. (Fig. 8.) The relationship before surgery had a great deal to do with attitudes after surgery. If antagonistic feelings existed prior to surgery, they did not improve afterward. However, in the majority of cases there was a sympathetic and helpful attitude of the members of the family toward the patient. During the first visit to the patient we generally requested that a member of the family be present. In this way the family would be acquainted with the problems the patient would have to face in the future. In a great majority of cases a member of the family was willing to help with the irrigation. The patient should be made to understand that the actual irrigation is his own responsibility. In some cases the patient relied upon his family so much that he would become quite helpless even as to the insertion of the catheter. This condition is to be avoided. It must be made clear to the patient that he is to be independent as soon as possible. He must be taught to be self-reliant and anxious to be on his own. He must not be allowed to become a burden to the members of his family.

Those *foods found difficult to tolerate* by the colostomy patients are: onions 95 per cent, cabbage family 78 per cent, baked beans 85 per

cent, fried foods, 45 per cent, alcoholic beverages 67 per cent, spices and salad dressings 73 per cent, iced drinks 42 per cent, fish 30 per cent, and nuts 20 per cent. These foods usually cause gas to escape from the colon. If the patient has gas, the physician may prescribe carbisol* tablets. The patient tries a new food every two days. If he can tolerate it, he can incorporate it in his diet. At times the fault may lie in the combination of foods used at the particular time. Often eating in restaurants may cause trouble because of various sauces and condiments put into the food.

Constipation. The patient is told that he will probably be able to eat the same foods he could eat before surgery. However, he is not to avoid the laxative foods such as fruit and raw vegetables. There is a general tendency for the patient to go on a low residue diet, and many doctors advocate constipative diets for colostomy patients. There is no worse condition than constipation for the colostomy patient. In cases of stubborn constipation, 50 to 100 mg. of colace or peri-colace is recommended, to be taken half an hour before breakfast and if necessary again half an hour before dinner at night. For proper emptying of the descending colon the fecal matter should have the consistency of toothpaste. At the same time the colon must be resilient and active enough to be able to empty itself. Both factors are important for successful irrigation (soft fecal matter and resilient colonic wall).

If a patient is constipated, he will have movements between irrigations. The reason for this is that the colon could not empty itself at the last irrigation. In cases of constipation, the pressure of water behind the fecal matter is insufficient to empty the colon. Therefore, most of the water remains in the colon at the time of the irrigation. It seeps out slowly during the next forty-eight hours and makes the patient not only uncomfortable but also anxious and apprehensive. The patient will notice that he has a clogged catheter, gas, inability to insert the catheter completely and inability to get a sufficient amount of water into the colon. These conditions must be avoided at all times. As a matter of fact, if a patient finds that his colon has been sluggish or that the fecal matter was too solid at the last irrigation, he must do something about it immediately. He must do one or both of the following: (1) increase his fruit and raw vegetable intake, (2) take a laxative prescribed by a physician, such as milk of magnesia, cascara, alophen,® colace or peri-colace. If the patient does not take this action immediately, he will find the state of constipation piling up on him, so that it will become increasingly difficult to manage the colon successfully. Those patients who were troubled with constipation before surgery are the most difficult cases to manage. Unfortunately, in a large number of colostomy cases constipation is often present. (Fig. 9.)

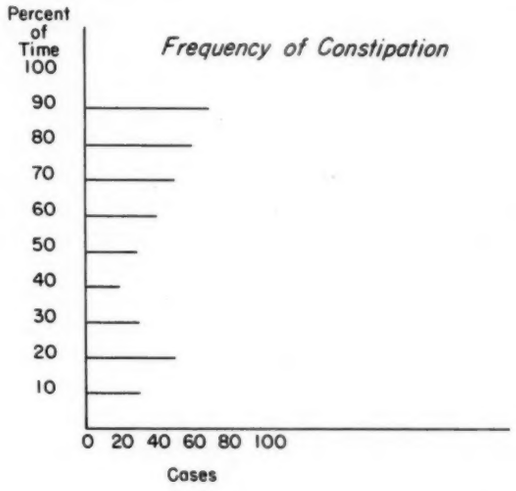

FIG. 9.

Spillage. This, of course, is a major worry in the mind of any colostomy patient. Spillage may be caused by constipation, diarrhea, emotional upset, intake of a drug like the "mycin" drugs, sudden shock, extreme fatigue, sudden changes in diet or water, or factors not discovered by the patient.

Unless spillage is held under control the patient may avoid social contacts, may change his type of occupation, may live in isolation and be lost to the world. Proper methods of irrigation, favorable attitudes and a close check on the colonic habits will keep spillage to a minimum. Under no circumstances should the physician allow his patient to seek other employment or to avoid social contact because of possible spillage. There are several methods which the patient can use to prevent spillage. The most important facts to remember are: (1) Keep the can at a low level during the irrigation, as brought out in Figure 3. (2) The patient may take a piece of kleenex or toilet tissue and

* May be obtained by writing to DOD Chemical Products Company, 3 Benhil Road, St. Paul, Minn.

twist the center of it until there is a pencil-like protrusion of about 2 inches. This is inserted into the colostomy. The tissue will begin to absorb the moisture in the colon. After an hour or two, when the tissue becomes wet, a new dry one may be inserted. If the lowest 2 inches of colon can be dried in this manner, peristalsis will stop for several hours and most of the time until the time of the next irrigation.

About 10 per cent of the patients are generally troubled with diarrhea or spillage a good deal of the time. This may be due to colitis, overactive colon, colonic irritability or constant tension situations. For these cases we prescribe, as necessary, 10 to 15 drops of deodorized tincture of opium immediately after an irrigation. Drugs may be prescribed as needed (doses of ¼ gr. phenobarbital, reserpine, Rauwolfia, thorazine,® sodium butisol,® sparine®). Avoid codeine, as it will paralyze the colon. Avoid the use of "mycin" drugs, as they may cause uncontrollable diarrhea. Desitin ointment may be used if there is irritation of the skin around the colostomy, or for lubrication of the catheter before insertion into the colostomy.

One must be careful in the use of vitamins containing iron or B_{12}. In most cases these will have an unfavorable effect upon the colon (paralysis of the colonic wall, with very soft fecal matter—seepage).

Dressing. The most inexpensive dressing that may be used after the colon has shrunk down to size is either kleenex, toilet tissue or gauze over the stoma. Over this the patient puts a piece of wax paper. This dressing is worn under a lightweight, elastic athletic support.

Irrigating Equipment. There are many kinds of equipment on the market but the best ones are those that have a plastic cup with an opening in the center large enough to admit a No. 24 F. catheter. The cup should have a neck at the bottom, over which may be put a rubber or plastic sheath which hangs down into the toilet. The fecal matter goes through this sheath and so avoids any mess in the bathroom that other methods may cause. It is better to use the open 2 quart enamel irrigating can instead of the rubber irrigating bag. If the patient uses the enamel can, he can look into it and see whether the water is going into the colon and how much water is entering. The norm is ¾ quart (as shown in Figure 4). Every surgical supply house sells colostomy bags or domes, but we condemn their use, as does every patient who has tried our method. The use of a bag is demoralizing to a patient. The bag may be odorous; it distorts the figure and may cause hernia, prolapse or weakening of the musculature around the stoma through constant use.

Employment. We have found that those patients who were rehabilitated on the twelfth to the fourteenth day after surgery, and without previous instructions, went back to their jobs about two months after surgery. This result is part of the rehabilitation program. Those persons who were not informed of the proper care of the colostomy could not return to their previous jobs and sought part-time employment or home employment. Many of these persons used the colostomy as an excuse for not returning to work at all. Of course if proper irrigating methods are not known, these patients have a valid excuse. The 400 patients we cared for were instructed early, so that 90 per cent returned to work. The other 10 per cent were too ill to continue.

A patient who had had no instructions at all for twenty-two years came for help, but we found that she had set up such strong but incorrect habits that she simply could not be rehabilitated. She put up obstacles every step of the way and gave reasons why our method could not possibly work. We had no such difficulties with patients who were instructed while they were in the hospital.

Some patients we met had worn bags for years. Most of these individuals lived in isolation. Some had used incorrect irrigating methods with disastrous results and were actually fearful of trying the irrigation again. Incorrect methods can cause uncontrollable spurts of water with feces for a period of twelve to twenty hours after an irrigation. This can happen if the irrigating can is held eighteen to twenty-four inches or even higher above the colostomy. No patient is rehabilitated if these things happen to him. He cannot plan for anything.

Some patients we met merely wore a dressing over the colostomy. They changed the dressing whenever it was necessary (usually seven or eight times a day) and did not irrigate. We do not advocate this method because of the odor and the uncertainty of the behavior of the colon.

Emotional stability was achieved in 80 per cent of the cases in which rehabilitation was early. Practically all the patients went through

a postoperative period of depression lasting about six months. Many were still apprehensive and worried out of proportion to the problem at hand. A great cause for alarm is surface bleeding during or after the irrigation, due to rubbing or irritation of the stoma. The patient with such bleeding was reassured as to the cause each time it happened, but the state of anxiety did not seem to diminish on the days when there was bleeding.

The state of depression gradually diminishes when the patients find that our method keeps them free from spillage and when they learn the mechanics of irrigation. Of course, those patients who were generally neurotic would have more difficulties than those who were emotionally more stable. While a patient is irrigating, he may get upset if the bell rings or if a visitor suddenly comes into the house, or even if a visitor is expected at a certain time during the irrigation. Many may have trouble with the colon if there is friction in, or rejection by, the family, or if someone is suddenly in need of the bathroom occupied by the patient.

We have found in all cases that the patient will be brought back to as near normal as possible with sympathetic reassurance and help when help is needed, along with the method of irrigation which will keep the patient free from spillage for forty-eight hours between irrigations without the use of a bag. We work toward the norm of each individual patient and we have found that deviations are not too great. For this reason we work with these averages; and if any deviations come up, they can be dealt with as the need arises.

"Ephraim McDowell, the father of gynecology, was born November 11, 1771 in Rockbridge Co., W. Va. . . . After the Revolution, the family moved to Danville, Ky. Ephraim's early education was meager. At the age of twenty he decided to be a physician. He returned to Virginia and entered the family of a Dr. Humphreys, of Staunton. After two years with this busy gentleman of mediocre talent he went to Edinburgh and began formal study. Here he remained two years. John Bell was his hero. Funds were not too plentiful, so Ephraim never took his degree, but returned home in 1795. He started practice in Danville, and was swamped with 'a great burden of practice.' For years he was the only surgeon in the state. In 1809, when thirty-eight years old and after fourteen years in practice, he performed ovariotomy. A Mrs. Crawford consulted him for what was diagnosed as a large ovarian tumor. McDowell had already made up his mind, as a result of Bell's fundamental teaching, what he would do whenever confronted with such a problem. McDowell and his nephew, James, operated on her. There was no preoperative preparation beyond giving Mrs. Crawford a large dose of opium. 'The patient being on the table, I marked with a pen the course of incision to be made; desiring him [nephew James] to make the external opening. I then took the knife, and completed the operation, as stated in the *Medical Repertory*. Although the termination of this case was most flattering, yet I was more ready to attribute it to accident than to any skill or judgment of my own; but it emboldened me to undertake similar cases; and not until I had operated three times . . . did I publish anything on the subject. I then thought it due my own reputation and to suffering humanity to throw all light which I possessed upon diseased ovaria.' McDowell sent a copy of his article to Bell in Edinburgh, and other copies to Wm. McDowell, his nephew and physician, and to Physick in Philadelphia. Physick never acknowledged its receipt. The nephew, however, took the story to Thomas C. James, and as a result, promptly published it in the *Eclectic Repertory*. The published cases were either unnoticed or not believed. The account sent to Bell fell into the hands of a Mr. Lizars, an Edinburgh surgeon, who was much impressed. The paper was published in the *Edinburgh Medical and Surgical Journal*. It was received with scorn. Before long, however, its value and worth were recognized. McDowell became a name throughout the medical world. . . . In 1807 the Medical Society of Philadelphia sent him its diploma. In 1825 the University of Maryland made him an alumnus with the honorary M.D. After a short illness Ephraim McDowell died on June 20, 1830." (T. S. W., *Am. J. Surg.*, 15: 556, 1932.)

The Posterior Triangular Space: Troublemaker of the Anus

RAYMOND E. ANDERSON, M.D., *McMinnville, Oregon*

THE common and distressing symptom of acute anorectal pain may develop from a number of inflammatory conditions in or about the anal outlet. An appraisal of the factors involved in the pathogenesis of anorectal infection reveals the exact posterior midline of the anal canal to be the focus of origin in the great majority of cases. This interesting fact is of considerable importance to the clinician who is frequently confronted with the problem and warrants an appreciation of the basic reasons as to why and how this relationship occurs.

Of the several spaces or potential spaces which surround the rectum and anus the posterior triangular space has received relatively little consideration in the past. As far back as 1909 Brick [1] described its confines and noted its capacity to harbor infection. Nesselrod [2], Pennington [3], Lockhart-Mummery [4] and others [5,6] have mentioned its role in the pathogenesis of anal inflammatory conditions but generally it has received more consideration as an anatomical landmark in the anal canal than as a focus of origin for many anorectal inflammatory lesions. Variously termed "the posterior triangular space," "the postanal space," "the triangle of Minor," or "the space of Brick," this potential compartment offers little resistance to the invasion of pathogenic bacteria and once invaded provides the ideal environment for development of serious chronic anorectal disease.

The possession of such annoying characteristics indeed qualifies the posterior triangular space to be termed the troublemaker of the anus. An analysis of the factors responsible for this distinction and an evaluation of the means by which early diagnosis and institution of proper therapy may be accomplished is offered in this discussion.

ANATOMICAL CONSIDERATIONS

The anal sphincter is made up of four distinct muscle bundles whose relationship to each other in the posterior midline delineates the boundaries of the posterior triangular space. Briefly described these are: (1) the *subcutaneous external anal sphincter* and the *corrugator ani muscle*, which together lie just below the skin, are arranged in a circular fashion and act as a purse string to the anal outlet. There are no bony or tendinous attachments to these muscles. (2) The *superficial external anal sphincter* lies immediately beneath the subcutaneous portion and is an oval- or triangular-shaped muscle which originates at the anococcygeal ligament and aponeurosis of the coccyx. It courses anteriorly to surround the anus and is inserted on the superficial transverse perineal muscle. Some of its fibers extend into the anterior pelvic diaphragm joining with the vaginal sphincter in the female or the bulbocavernosus muscle in the male. The heavy bundles of this muscle course parallel in the anteroposterior plane and account for the configuration of the anal slit in the sagittal direction. (3) The *deep external anal sphincter* is also a heavy bodied muscle whose fibers, however, are again circular. This muscle lies superior (deep) to the components already mentioned and has no anterior or lateral attachments. Posteriorly its fibers blend with those of the puborectalis to produce the sling-like support to the anal canal. (4) The *internal anal sphincter* is an involuntary muscle which represents a thickening of the terminal circular fibers of the rectum. Its position is central to the superficial and deep external anal sphincters and it extends as far as the intermuscular septum of the anal canal. The primary function of this muscle is to aid in the propulsion of stool

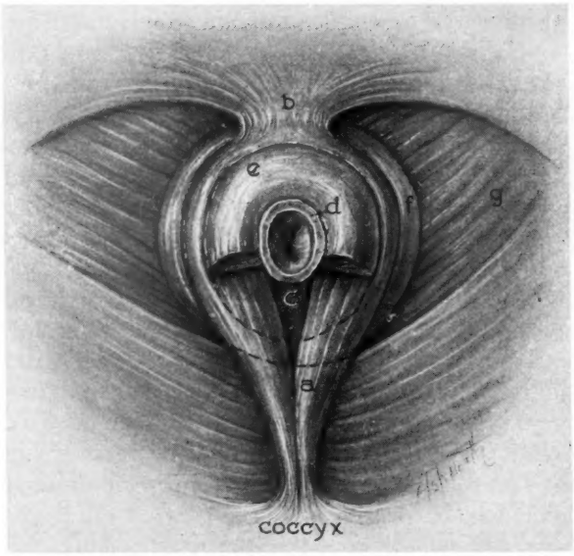

FIG. 1. Diagrammatic representation of the anal sphincter mechanism, showing the location of the posterior triangular space. The muscle bundles are not as delineated nor is the posterior triangular space as large in the natural state as this diagram indicates. (*a*), The superficial external anal sphincter. (*b*), The anterior fibers of the superficial external anal sphincter converging with the superficial transverse perineal muscle. (*c*), The posterior triangular space. (*d*), The cut edge of the internal anal sphincter. (*e*), The subcutaneous external anal sphincter. (*f*), The deep external anal sphincter. (*g*), The puborectalis muscle which blends posteriorly with the deep external anal sphincter to produce the "anal sling."

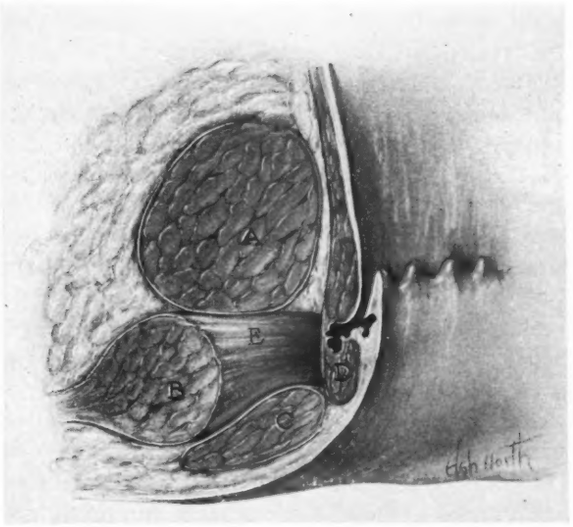

FIG. 2. Diagrammatic representation of the posterior anal wall in cross section, showing the boundaries of the posterior triangular space. The relationship of the anal gland is shown, the size of the gland being exaggerated considerably. A, deep external anal sphincter with the posterior fibers of the puborectalis muscle. B, the posterior fibers of the superficial external anal sphincter. C, the subcutaneous external anal sphincter. D, the internal anal sphincter. E, the posterior triangular space.

from the rectal ampulla and it has little to do with the maintenance of the anal tone.

It is apparent from a study of the architectural arrangement of the sphincter mechanism that in the exact posterior midline there exists between the circular fibers of the subcutaneous sphincter below and the deep sphincter above a potential weakness in the wall of the anal canal where the converging fibers of the superficial layer have not yet joined. This "Y"-shaped deficiency is protected only by the fibers of the internal sphincter although its confines are well invested in a layer of sphincteric fascia. Courtney's [*7*] dissections indicate that the posterior anal space may extend as far as the iliococcygeal muscle above and the levator layers laterally while the inferior border may reach to the coccygeal raphe and lower layer of the puborectalis muscle. As the space is a potential one only, filled with loose areolar tissue, its presence is difficult to delineate when the sphincteric muscles are in a normal state of contraction. Under anesthesia, however, or when the area is invaded by disease the space is readily identifiable. (Figs. 1 and 2.)

ANAL INFECTION

The pathogenesis of anal infection has been documented well by Tucker and Helwig [*8*], Nesselrod [*9*] and others [*10*]. Particles of bacteria-laden stool enter the funnel-like anal crypts and become lodged in the ducts of the anal glands. An inflammatory reaction is established which results in edema, obstruction and deep suppuration of the glandular substance. If the organisms are of an especially virulent nature, or the resistance of the host is low, the process continues and invasion of the perianal or perirectal tissue takes place. The glands, therefore, represent the avenues by which infection gains access to the spaces surrounding the anal outlet. While the presence of the anal or intermuscular glands has been an established fact for a number of years their significance in regard to anal infection has not been generally appreciated. Originally it was assumed that the glands were vestigial structures only, lying in the subcutaneous tissue of the anal outlet. Recently it has been demonstrated that many of the glands lie in the deeper

anal musculature or the intermusculature connective tissue, course in a cephalad direction to perforate the fibers of the internal sphincter and empty by means of a simple duct into the base of one of the anal crypts. Any quadrant of the anal outlet may contain these tubular branching structures but the studies of Kratzer and Dockerty [*11*] have shown that the greatest number are concentrated into the crypts of the posterior midline.

The forward angulation of the rectal ampulla along the hollow of the sacrum results in the greatest pressure of stool directed to the anorectal line at the posterior shelf. This added pressure thus concentrated upon the area of the anus containing the highest localization of anal glands would appear to increase significantly the likelihood that this portion of the anus is subjected to invasive infection more often than any other area. Perforation into the posterior triangular space lying in immediate proximity and anatomically vulnerable follows as a logical sequence in a well defined process.

CLINICAL CONSIDERATIONS

Invasion of the posterior triangular space is the primary means by which several inflammatory lesions of the anorectum become established.

Abscess. Unopposed bacterial growth within the posterior triangular space is likely to result in early abscess formation within the compartment. Eisenhammer [*12*] has recently described such a lesion lying within the perianal intermuscular tissue but it is extremely rare to observe the phenomenon occurring within any other intersphincteric area other than the posterior midline, namely, within the triangular postanal space.

The accumulation of purulent material within the small confines of the space occurs rapidly but the fascial investments limit its spread for a period of time. Localization at this point represents the fundamental pathological process, preceding all other stages of chronic anorectal inflammatory disease in this portion of the anal canal. Upward extension of the abscess into the higher intermuscular space, deep to the internal sphincter muscle is not uncommon and may tend to confuse the identity of the basic source of origin.

Fistula. Regardless of its location every fistula-in-ano is the consequence of an initial abscess which has found its way to a cutaneous surface either by spontaneous perforation or as the result of surgical drainage. It is significant that the internal opening of approximately 80 per cent of all anal fistulas may be found in the posterior midline from an original source in the posterior triangular space [*13*]. The advancing infection may progress in almost any direction. Most commonly the ischiorectal spaces are involved, for the loose areolar tissue in these fossae offer little resistance to rapid bacterial growth. The subsequent mucocutaneous fistula will then have its secondary opening lateral or posterior to the anal outlet. This phenomenon was observed a number of years ago by Goodsall [*14*] who applied it as a rule in the localization of the primary opening of anal fistulas whose secondary or external exit was identifiable on the perineum. This rule states that all external fistulous openings which lie behind an imaginary line, drawn transversely across the perineum through the center of the anal outlet, have their internal openings in the posterior midline. All fistulas with external openings anterior to the line have their primary opening immediately opposite (radial), hence the tract is straight. Goodsall's original explanation for the rule which now bears his name was that posterior infection was deflected laterally by the coccygeal attachments of the superficial portion of the external anal sphincter. Nesselrod, however, found a more logical answer in his studies of the lymphatic drainage of the anus. The infection, once it has broken its barriers, undoubtedly spreads by lymphatic channels. Those of the anus follow a curved pathway flowing from the posterior midline in an anterior direction to empty into the inguinal glands. A primary focus in the posterior anal wall will, therefore, migrate in a lateral and anterior direction, rather than posteriorly, while infection elsewhere will follow the lymphatics by a more radial course.

Fissure. The troublesome characteristics of the posterior triangular space is reflected also in the fact that, as with fistula-in-ano, the great majority of acute anal fissures occur in the posterior midline of the anal canal. Over 90 per cent of ulcers develop in this area and owe their presence to original involvement of the adjacent triangular compartment. Instead of a lateral or posterior penetration and migration of the infection into the perianal tissue, perforation back to the crypt originally invaded may occur. Such an event relieves the immediate pressure

of the abscess but results in a chronic focus of inflammation. Unable to drain properly, constant reinfection takes place which fills the base of the cavity with granular debris and scar tissue.

The posterior transverse fibers of the subcutaneous portion of the external anal sphincter delineate the inferior border of the posterior triangular space, this portion of the muscle sometimes being referred to as "Blaisdell's bar." Normally these fibers will stretch easily with the passage of stool as the posterior bundles of the superficial body of the muscle separate beneath them to allow the anal canal to open. Chronic infection in the posterior triangular space, however, creates spasm, eventual fibrosis and fixation of this portion of the muscle. Because of the inelastic state, splitting or tearing of the fibers readily occurs with laceration or abrasion of the overlying tegumentary layer. A fissure thus created cannot heal until the basic cause of its presence is corrected, and secondary infection at the base of the ulcer rapidly develops. As edema, lymphatic stasis and scar tissue evolve, the distal margin of the ulcer becomes undermined and congested with the ultimate formation of a tag of inflamed tissue often called the secondary or "sentinel" pile.

Papillitis, Cryptitis and Pectenosis. Bacteria of a low virulence may gain entrance into the posterior triangular space and perforation or erosion may not take place early. Instead a local chronic, annoying, inflammatory reaction ensues. The anal papillae or the crypts in the posterior midline become thickened and congested. The subcutaneous tissue and pectin fascia lose their elasticity and fibrosis develops. Secondary invasion by more virulent pathogenic bacteria is common, and without local defensive mechanisms for protection a spreading cellulitis results readily.

DIAGNOSIS AND THERAPY

The posterior triangular space, lying as it does distal to the mucocutaneous line, is innervated by the somatic nervous system. Sharp burning or throbbing pain, therefore, is an early symptom of localized infection. As the compartment is bounded by definite fascial planes and is actually a relatively small space, the purulent matter produces considerable pressure within a short period of time. This factor is the basis for the typical history of a sudden and severe onset of severe anal pain (eight to twelve hours). Unlike the pain pattern of an anal fissure, in which there may be quiescent periods following bowel movements, the triangular space abscess produces constant and unremitting distress which is not affected by the local insertion of suppositories or the application of anesthetic ointments. The pain may radiate to the anterior perineum or genitalia or the buttocks and low back. There may be tenesmus or dysuria.

The symptoms will persist until perforation from the space occurs, at which time the acute pain will subside to be replaced at a later period by a secondary pain originating in whatever adjacent structure may become involved by the infectious process. Examination of the anal outlet during the acute stage of the lesion reveals extreme spasm of the sphincteric mechanism, brawny induration of the anal skin in the posterior quadrant and a palpable mass in the posterior midline just distal to the base of the anal crypts. The papillae over the involved area are usually inflamed and engorged. Chills and fever are not common although a feeling of malaise may be experienced by some people.

The treatment of the posterior triangular space abscess consists of immediate surgical drainage of the infected cavity. The administration of antibiotics does little good at this stage and the application of hot packs or anesthetic ointments, while perhaps making the patient temporarily more comfortable, will not alter the course of the disease. It is unwise to attempt surgical drainage with anything less than a general anesthetic. Local infiltration of anesthetic agents is far from satisfying and offers every opportunity for bacterial spread into the adjacent muscles. Intravenous sodium pentothal® affords enough relaxation of the sphincters for the insertion of a speculum into the anal canal and rapid evacuation of the abscess. Prior to making the actual incision a curved probe is introduced into the posterior anal crypt directly proximal to the posterior triangular space and the abscess localized by this maneuver. The insertion of the probe will generally allow the escape of 1 or 2 cm. of pus which may be all that the cavity contains. Nevertheless, an incision is made in the exact posterior midline and the crypt, its ducts and the triangular space are opened to their base. The incision must be carried down through the lower border of the internal anal sphincter mus-

cle and through the subcutaneous portion of the external anal sphincter in order to expose the depths of the infected area completely. A triangular wedge of skin is removed distal to the incision to allow adequate drainage. This posterior sphincterotomy will not result in any degree of incontinence and the surgeon must completely transect all fibers of the subcutaneous muscle without hesitation. Postoperative packs or drains should be avoided, although a Montager catheter may be inserted into the rectum for twenty-four hours. Routine postoperative orders utilize antibiotics, sitz baths and adequate sedation. Starting on the fourth postoperative day gentle dilations of the anus are performed and repeated every four to seven days until healing of the skin has taken place. This occurs within ten to fourteen days following surgery.

SUMMARY

The posterior triangular space of the anus is an important anatomical landmark in the anal canal. This potential compartment lies between the subcutaneous and deep components of the external anal sphincter and within the V-shaped convergence of the posterior fibers of the superficial portion of that muscle. The central boundary of the compartment is made up of the fibers of the internal anal sphincter. Infection gains entrance to the space by means of bacterial growth in the anal crypts, passage along the anal ducts and finally invasion of the anal glands with perforation into the adjacent potential space. Localization in the posterior space is the initial phase of the development of fistula-in-ano, anal fissure, pectenosis and cellulitis. Early diagnosis is important and immediate and adequate surgical drainage with posterior sphincterotomy is essential in order to prevent the development of these undesirable sequelae.

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Third Degree Burns of the Dorsum of the Hand

JOHN A. MONCRIEF, M.D., *Atlanta, Georgia*

From the U. S. Army Surgical Research Unit, Brooke Army Medical Center, Fort Sam Houston, Texas.

BURNS of the hand result in an alarmingly high percentage of thermal injuries. At the U. S. Army Surgical Research Unit, Brooke Army Medical Center, 75 per cent of the burned patients had sustained burns of the hands; 80 per cent of the wounds were bilateral. The burned patient frequently sustains involvement of the hand as a result of protective action in an attempt to cover his face or eyes, or in an effort to extinguish a flame elsewhere on his body. The depth of the burn will vary with the cause, but even a flash burn often causes full-thickness skin loss on the dorsum of the hand. In our experience, third degree burns of the palmar surface of the hand are rare, unless caused by electricity, chemicals or contact with a hot object. Burns of the flexor surface of the tips of the fingers or the margins of the thenar or hypothenar areas are frequently third degree; but the remaining area of the hand, particularly the palm, sustains full-thickness skin loss only under the most unusual circumstances. This escape from a third degree burn is the result of a combination of the thickness of the skin and the protective reflex of clenching the fists. The dorsum of the hand, however, is not immune to full-thickness skin loss; on the contrary, complete destruction of the skin may occur from relatively minor burns. The exposed position of the dorsum of the hand, the small amount of subcutaneous tissue and the relatively thin skin are contributing factors to full-thickness skin loss.

These same factors that contribute to easy destruction of the skin on the dorsum of the hand and digits also afford little protection to the intrinsic structures of the hand beneath the skin and the thin layer of subcutaneous tissue. The most readily involved of these deeper structures is the extensor mechanism from a point at the mid-level of the metacarpals through the distal interphalangeal joint. Particularly over the metacarpal-phalangeal joint and the proximal interphalangeal joint is the extensor mechanism most exposed. (Fig. 1.) Here it is covered by thin skin, practically no subcutaneous tissue and no tendon sheath, and therefore frequently involved by direct thermal injury. If the thermal injury is of considerable depth, the joint capsule of the interphalangeal joint may be destroyed in the dorsal area. Even though not completely destroyed, the fibrosis and scarring that result from thermal injury may cause marked limitation of motion of these joints. Because of their exposed position the phalanges may sustain a burn of sufficient depth to devitalize the periosteum and completely destroy the overlying tissues. If persistent edema results from the thermal injury, it will cause a woody induration and fibrosis of many intrinsic muscles of a hand, particularly those in the thenar space.

Exposure to a burning agent is of short duration in those patients who survive; therefore the thermal injury is immediate and not progressive. However, infection that almost invariably accompanies any type of burn produces further destruction of tissue. If infection is not checked, it may completely disable a hand that was functionally useful right after the thermal injury. Conversion of a partial-thickness burn to a full-thickness skin loss may occur quite rapidly. When the extensor mechanism is still intact following the initial thermal trauma even though full-thickness skin loss has occurred, this delicate mechanism may be completely destroyed by autolysis resulting from bacterial proliferation. Such a condition is apt to occur in the area of the middle slip of the extensor tendon at the proximal inter-

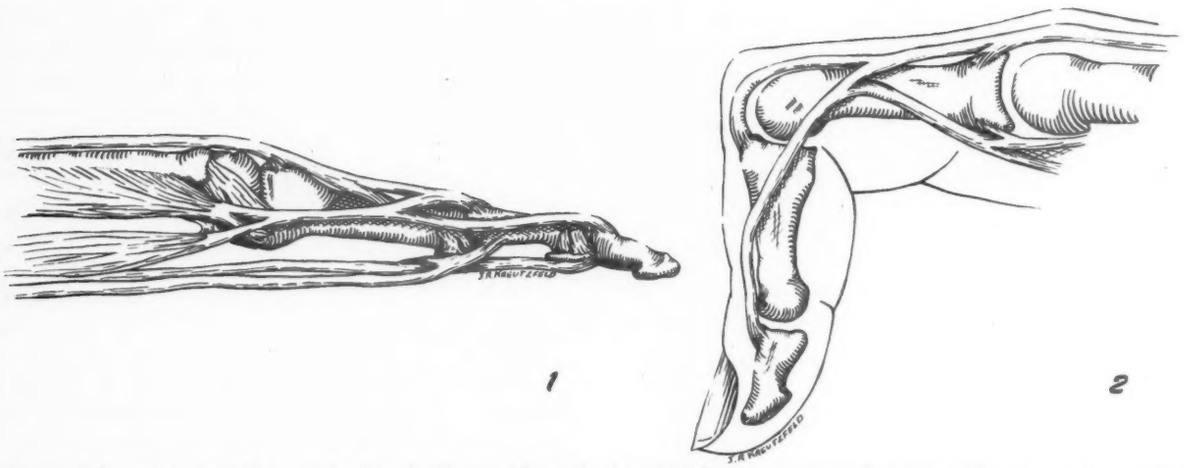


FIG. 1. The digital tendon mechanism is shown. Note the interlocking arrangement of the extensor tendon proper and the interossei and lumbricals. This stabilizes the proximal interphalangeal joint and strengthens the extensor power.

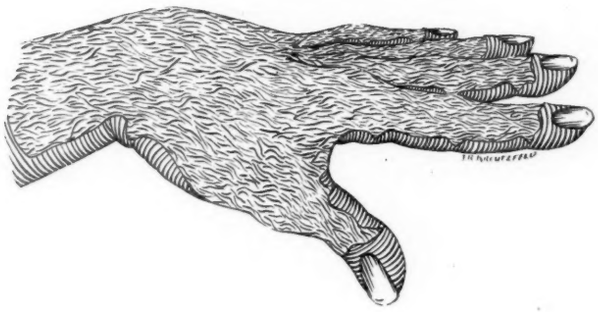
FIG. 2. The extensor hood expansions have been omitted. Note the tendons on the sides of the proximal interphalangeal joint move ventrally during flexion of the joint. The force of these tendons is thus transformed into one of flexion. With destruction of the middle extensor slip by a burn or infection, the attitude of flexion is maintained.

FIG. 3. The patient was first seen fourteen days post-burn with grossly infected eschar over dorsum of hands. Above deformity with fusion of joints resulted from destruction of extensor mechanism by bacterial autolysis.

phalangeal joint and at the point where the extensor tendon passes over the head of the metacarpal bone near the metacarpal-phalangeal joint. The absence of a protective tendon sheath, the poor blood supply afforded by the peritenon, and their partial devitalization because of the thermal injury provide little opportunity for survival of this extensor mechanism. (Fig. 2.)

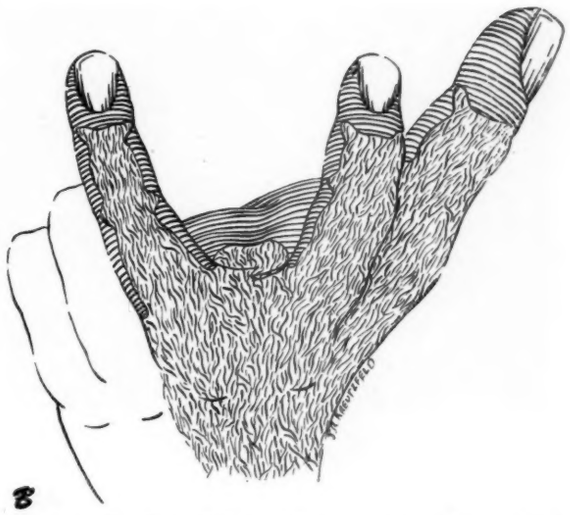
If either the extensor mechanism, the joint capsule or the joint are destroyed by the thermal injury, fusing the joints in the maximum position of function is the only treatment for restoring any functional use of the hand. Skin coverage should then be attempted. Frequently exposure of the phalanges results in amputation. In some instances, granulations may be stimulated by drilling into the marrow and thus obtaining skin coverage for the digits. This procedure, however, does not result in a fully functional hand. If this type of injury has occurred because of burning, further functional loss must be prevented and the joints must be maintained in a position that will produce the maximum function upon attaining skin coverage.

Reason for This Study. Because the conventional method of treatment of burns on the dorsum of the hand resulted in functional loss out of proportion to the direct thermal injury, a study was initiated to determine some method that might prevent this occurrence. In our experience, the usual method of treating burns does not prevent the autolytic bacterial destruction of the extensor mechanism beneath the third degree eschar. It was thought that this destruction might be prevented by early surgical removal of the third degree eschar. This procedure would convert an infected wound into a relatively clean wound; thus functional loss could be minimized or prevented. The areas of third degree burn must be covered as soon as possible with split-thickness skin grafts. (Fig. 3.)



A

FIG. 4A. Diagram of areas of skin excision. Note the dart projections over joints and the mid-lateral position of lines of excision on the digits. The area of burn often requires circumferential excision at the wrist and occasionally of the tips of digits.



B

FIG. 4B. The interdigital web space must be excised to prevent webbing which on occasions may be extreme. The thenar space is treated similarly. The belief that either a dorsal or ventral web will result from any type of procedure is an absolute fallacy.

SELECTION OF THE PATIENT

In selecting patients for this type of therapy it was difficult to determine the exact depth of the burn. It was not possible to differentiate between a deep second degree and superficial third degree burn in many areas. However, in every instance the areas of full-thickness skin destruction were sufficiently widespread so that few questionable areas had to be removed in order to assure the optimum functional result after healing. It is to be emphasized that these burns were obviously deep burns, including full-thickness skin destruction.

The extent and depth of burn elsewhere on the body, particularly in a patient whose survival was of primary concern, dictated a type of therapy other than that considered optimal from a functional standpoint. In such patients the areas of full-thickness burns of the hand were not excised early for the simple reason that, from a survival standpoint, the extensive amount of skin required for coverage could be used to better advantage in some other area of the body. Patients were excluded from the study if bacterial autolysis of the areas of full-thickness burn had already begun. They were excluded because previous experiences had shown that if autolysis occurred surgical excision caused excessive bleeding and the tissue planes could not be delineated satisfactorily. In all probability the infection had penetrated to such a depth that even excision could not prevent further bacterial destruction of the intrinsic mechanisms.

Experience indicated that the bacterial autolysis generally began by the fourth or fifth day; therefore it was decided to excise the full-thickness areas prior to that time. The study was at the half-way point before any patients were admitted soon enough after injury for excision to be performed within the first forty-eight postburn hours. As a consequence, in most of the patients the areas of full-thickness burn were excised between forty-eight and seventy-two hours after injury.

In a few patients, however, surgical excision of the full-thickness burn was performed within eighteen to thirty-six hours, and the results were so discouraging that excision was discontinued at such an early interval. Although this earlier excision was in no respect different from that carried out within forty-eight to seventy-two hours, the amount of edema noted at subsequent dressing changes, grafting episodes and during the early convalescence period was much greater and frequently resulted in interference with the graft survival and a diminished functional return.

TECHNIC OF EXCISION

The excisional procedure is carried out under tourniquet ischemia and the type of anesthetic to be used is determined by the patient's general

FIG. 5A. Third degree burns of dorsum and second degree burns of palm, except for margins of thenar and hypothenar areas. Twenty hours postburn.

condition. A brachial block or general anesthesia is equally satisfactory from a technical standpoint. An accepted procedure of the Unit is the simultaneous excision of adjacent portions of the arm or forearm that have full-thickness skin loss. This simultaneous procedure is not absolutely necessary, however, and its use is dependent on a patient's general condition and the practical aspects of therapy. The excision is performed to a depth sufficient to insure removal of all devitalized tissue. If the vessels in an area are not thrombosed, the tissue is probably viable. Every attempt is made to keep the venous network over the dorsum of the hand intact in order for the perivascular lymphatics to minimize the amount of edema after excision and grafting, and thus speed the return to function. The peritenon must be preserved in order to prevent further impairment of the already tenuous blood supply to the extensor mechanism. The surgeon must be careful not to remove the peritenon in the area of the metacarpal-phalangeal or proximal interphalangeal joint where it is quite superficial, quite thin and hard to distinguish from surrounding tissue.

The same principles of hand surgery are employed in this method of treatment of the burns as are used in the treatment of any type of hand injury. In an attempt to preserve as much skin as possible, the prevalent tendency is to do an excision that is not adequate from a functional standpoint. This usually occurs when the surgeon fails to carry his excision to its logical conclusion because of his reluctance to remove skin that is not completely devitalized. Even though the extensor mechanism may be preserved by surgical intervention, function can be markedly impaired by the improper placement of the lines of excision. (Fig. 4.)

GRAFTING PROCEDURE

The time at which grafting is carried out depends on the general condition of the patient and the experience of the surgeon. Usually the condition of the patient will allow for grafting at the time of excision. It usually requires from two to two and a half hours to excise one hand. When the forearm is also involved, the procedure may last another hour. Although the tourniquet may be released intermittently, a three-hour period is a long time for the application of ischemia to an extremity. For that reason, the surgeons conducting this study have been reluctant to perform the excisional procedure and grafting at the same time. Another important factor entering into the surgeon's decision is the difficulty of determining the viability of the superficial tissue following excision. Consequently, after excision injured hands were immobilized in large pressure dressings and elevated to minimize the edema; the grafting procedures were then carried out forty-eight to seventy-two hours later. This procedure has proved advantageous. There was only one instance in which difficulty was encountered. Unsatisfactory function resulted because the surgeon had failed to recognize the extreme depth of the burn and the initial excision was not deep enough. It was believed that the functional result would have been even worse if grafting had been carried out at the time of the excision.

A tourniquet is used throughout the grafting procedure and a pressure dressing is applied prior to removal of the tourniquet. Unless a graft is applied under tourniquet ischemia, bleeding will jeopardize the graft take.

The optimum areas for obtaining donor skin are the chest, abdomen and anterior medial thigh. The skin in these areas is relatively thin and, as a consequence, a thick graft will be more elastic. (Fig. 5.)

The choice of dermatome to be used depends on the skill of the surgeon, but he should avoid a free-hand knife unless he is extremely skillful. The graft is taken at 20 to 25 $\frac{1}{1000}$ths of an inch and applied without tension. The grafts are placed so that the junctional scar passes transversely across the hands or digits. The

FIG. 5B. Six days postburn and three days postexcision. Day of grafting; compare functional lines and treatment of web spaces on the two hands.

FIG. 5C. Eighty days postburn. Note webbing on left hand. Physiotherapy for seventy-two days.

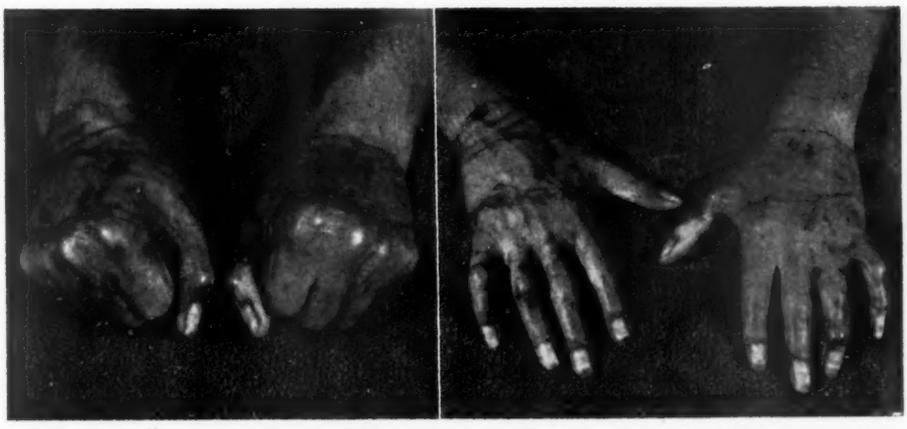


FIG. 5D. One hundred twenty-one days postburn. Patient was back to full occupational work as an IBM operator for forty days. Webbing is progressing but is causing no functional limitation in this case at this time.

FIG. 5E. One year postgrafting. Note the loose, elastic quality of the skin which affords an excellent functional result.

skin taken for the graft should be allowed to retract as much as possible so that a minimum of stretching will result from suturing the graft in place. These precautions are important, as regaining function after healing will largely depend on the elasticity of the grafted skin. If grafts are properly applied, no additional split-thickness, full-thickness or pedicle grafts will be necessary to regain a full range of motion. A surgeon must use fine sutures and attain an accurate approximation of the skin margins.

Upon completion of the grafting procedure, a large pressure dressing is applied to include the entire hand, arm and forearm in a position of flexion with the elbow at an angle of approximately 15 to 20 degrees. An attempt should be made to extend the wrist, to hold the thumb in complete abduction, and to flex the metacarpal-phalangeal joints at 90 degrees in order to obtain maximal stretching of the capsule. Frequently this position is difficult to maintain; nevertheless, it should be attempted and held in place by the dressing. (Fig. 6.)

Dressings are changed three days after grafting and the sutures are removed. The graft is adherent enough at this time to cause no difficulty when a dressing is changed. After the initial dressing change, the hand, arm and forearm are again immobilized in the same manner as previously. Three days later the dressings are removed and the hands are exposed. The patient is instructed to keep his hands in an elevated position.

PHYSIOTHERAPY

A patient begins physiotherapy eight to ten days after grafting. It is imperative for this therapy to be carried out at such an early date in order to increase the range of motion as rapidly as possible. Unless this therapy is carried out, joint capsule fibrosis and scarring may progress to such an extent that extreme functional impairment occurs. During the time when a hand is not in use, it must remain elevated to facilitate lymphatic drainage and thus minimize the amount of woody induration that may form in the intrinsic muscles of the hand. This induration is characteristic of the adductor muscles of the thenar web and may so limit abduction of the first metacarpal that it cannot be relaxed by any correction of skin covering or by physiotherapy.

RESULTS

Seventeen patients sustaining full-thickness burns of the dorsum of the hand have been admitted to the Unit. (Table 1.) In these seventeen patients a total of twenty-seven hands were involved in full-thickness skin loss that were treated by early excision and grafting. With the exception of two patients, all the digits sustained full-thickness burn and the damaged skin was excised. The dorsum of the hand was excised in all twenty-seven hands. In fifteen patients the forearm was also excised circumferentially, usually up to and occasionally including the elbow.

Excision of third degree burn was accomplished at varying periods of time from the day of injury to the seventh postburn day. As experience in regard to the time of excision was acquired, it became evident that the interval from forty-eight to seventy-two postburn hours was the optimum period for excision. In many instances, however, the patient was not admitted to the Unit until after the third postburn day. In a few instances the general condition of the patient prohibited such a prolonged operative procedure. Excision of burned areas prior to forty-eight postburn hours presented no technical difficulties. However, during the subsequent dressing changes and grafting period it was noted that the edema of the viable subcutaneous tissue persisted and it was thought that this condition might possibly interfere with the success of the graft takes. In one patient edema persisted for such a long

FIG. 6. One hundred fifty-four days postburn and 153 days postexcision. Grafted three days postburn. The middle slips of extensor mechanism on second, third and fourth digits of right hand were destroyed by fire. Those joints were pinned, resulting in fusion in the position shown. There is an excellent functional result. (Note that the third degree burns of the forearms were also excised. The venous network remains quite prominent.)

time that it was difficult to determine the viability of the tissue and grafting had to be postponed.

Grafting of the excised area was carried out from two to thirteen days following excision. Skin coverage in the majority of the patients, however, was attained on the second or third day. All dressings were changed two or three days after excision of a full-thickness burn. At the time of the initial dressing change, the appearance of the excised area was the basis for determining whether or not grafting should be performed. In only two instances was grafting delayed until a subsequent dressing change. In both patients postponement of grafting was due to persistent edema and difficulty in determining the viability of the dorsum of the hand or the digits; therefore it was not considered wise to jeopardize the graft takes.

The area of grafting was determined by the area of excision. It was of primary importance from the standpoint of restoration of function that the excision be carried to the mid-lateral portion of the digits. Deep darts were made over the interphalangeal joint areas. Excision of both the interdigital web spaces and the thenar web was carried out well onto the palm. The areas of the thenar and hypothenar space eminences requiring excision were removed in such a manner that their margins were in a broken, curved line.

When dressings are not changed on the second or third day after grafting, considerable graft loss may occur as a result of infection in the area of second degree burn on the palms and digits. Even though such graft loss might not be extensive, it would occur where the graft joins the mid-lateral portion of the digits. The subsequent scarring that would probably result might be significant enough to decrease percentage of function after the hand is healed. (Fig. 7.)

Physiotherapy is instituted as soon as the surgeon determines that the graft takes are

TABLE I

Patient No. and Type of Burn	Sex and Age (yr.)	% Burn		Area Excised				Day Postburn					Remarks†
											Range of Motion*		
		Total	3rd Degree	Hand	Digits	Dorsum	Forearm	Excision	Graft	Physiotherapy	Adequate	Full	
1 Flame	M, 20	16	2	Right	Index and thumb	+	..	6	8	15	20	...	Thumb extensor exposed by graft failure; after coverage had stiff interphalangeal joint of thumb; thenar web indurated; no relief with regrafting of thenar web due to adductor fibrosis
2 Flame	F, 22	30	10	Right	All	+	+	6	9	16	40	135	Persistent edema of palmar surface of digits and hand for 3 mo. postgraft; with continued physiotherapy only limitation at 135 postburn days was fusion of proximal interphalangeal of fifth digit
3 Flame	M, 48	27	15	Right	All	+	..	3	5	....	....	...	Died 8 days postgraft due to hepatic failure; 100% graft take with good range of motion at 6 days postgraft
				Left	All	+	..	3	5	....	....	...	
4 Flame	M, 24	55	43	Right	All	+	+	3	5	....	16	...	Died 33 days postburn due to septicemia; at 16 days postburn had good range of motion of hand with mobile joints
				Left	All	+	+	3	5	....	16	...	
5 Flash	M, 34	17	3	Right	All	+	..	6	6	14	21	40	No difference in graft take; on left hand interdigital webbing developed due to failure to excise unburned interdigital spaces; at 6 mo. postburn skin tough, relaxed and loose and possessed all the mobility of unburned skin
				Left	All	+	..	3	6	14	21	40	
6 Flame	M, 21	38	15	Right	All	+	+	7	9	30	60	...	Excision and grafting delayed due to poor general condition; physiotherapy delayed because of upper arm burn; function diminished because of thermal destruction of extensor mechanism of middle and ring fingers; thenar web fibrosis
7 Flame	M, 23	31	16	Right	All	+	+	6	9	40	60	...	Progress delayed on right due to osteomyelitis of middle and proximal phalanx of middle digit secondary to burn into proximal interphalangeal joint; digit amputated after obvious progression of osteomyelitis; regained full metacarpal-phalangeal motion but 20% limitation of proximal interphalangeal joint
				Left	All	+	+	6	9	20	35	60	Rapid return of function despite loss of middle slip of left third; developed fibrous ankylosis with only limitation being ankylosis of proximal interphalangeal of third digit and ankylosis of 2–5 distal interphalangeal joint
8 Flame	M, 26	25	6	Right	All	+	+	0	3	12	30	...	Deep burn destroyed middle slips on right 2, 3 and 4; these were pinned, which resulted in the only limitation of motion of either hand; skin soft and pliable very rapidly
				Left	All	+	+	0	3	12	30	45	
9 Flame	M, 39	16	2	Right	All	+	..	0	3	26	40	60	Initial graft take only 85% due to very deep burns over dorsum and edema; regrafted; excellent functional result with no limitation

TABLE I (*Continued*)

Patient No. and Type of Burn	Sex and Age (yr.)	% Burn		Area Excised				Day Postburn					Remarks†
											Range of Motion*		
		Total	3rd Degree	Hand	Digits	Dorsum	Forearm	Excision	Graft	Physio-therapy	Adequate	Full	
10 Flame	M, 33	25	12	Right Left	All All	+ +	+ +	1 1	14 14	30 30	60 60	... ...	Burn much deeper than initial estimate; grafting delayed due to deep loss of tissue, marked edema and septicemia; homografts used initially; all proximal interphalangeal joints pinned due to loss of middle slips; partial fibrous ankylosis of all metacarpal-phalangeal joints due to burn; poor result due to very deep burn
11 Flame	M, 20	50	18	Right Left	All All	+ +	+ +	3 3	6 6	....	....	... ...	Excellent graft take but patient died of septicemia 14 days postburn
12 Flash	M, 22	11	1	Right	2 & 3	+	..	2	4	13	20	30	Initial graft failure in two small areas; regrafted at 8 days postburn; rapid return of function with full range of motion
13 Flash	M, 22	17	2	Right	All	+	..	2	8	19	30	...	Initial loss of graft in 2 web spaces requiring regrafting at 12 days postburn; extensive capsular fibrosis and some vesiculation of graft with considerable functional limitation at 90 days postburn; may require relaxing graft if no further progress with physiotherapy
14 Flame	M, 25	24	5	Right Left	All All	+ +	.. ..	2 2	5 5	15 15	22 22	30 30	Excellent graft take and rapid return of function; only difficulty is with rapid interdigital graft webbing
15 Flame	M, 38	29	5	Right Left	All All	+ +	.. ..	2 2	5 5	15 15	22 22	30 30	No limitation; excellent graft take with rapid return of function
16 Flash	M, 18	19	6	Right Left	All All	+ +	+ +	2 2	5 5	18 18	26 26	40 50	Marked edema of left arm and hand persisting for 4 wk. postgraft; 30 days postburn still had only 30 degree flexion of metacarpal-phalangeal joints due to fibrosis; however, with continued physiotherapy recovered except for weakness in all left thumb movements
17 Flame	M, 26	18	5	Left	All	+	+	5	7	15	20	36	Excellent graft take; rapid return of function
Averages	27.1	26.3	10	.....	.....	..	..	3	6.4	19.1	30.4	44	.....

* A full range of motion included joint movement and fine coordinated action. An adequate range of motion included all movements necessary in usual activity such as eating, writing, grasping small objects, buttoning clothing, etc. The main limitation in these was decreased thumb abduction due to thenar fibrosis, metacarpal-phalangeal capsule limitation of minor degree and surgical fusion of the proximal interphalangeal joints.

† Except for the one case in which persistent edema delayed full return of function for 135 days, recovery was rapid. However, it is amazing how long improvement will continue in all cases.

FIG. 7. Thirty days postgraft. Note the scarring beginning already at the graft margins on digits where lines of excision were incorrectly placed. Dorsal interdigital webbing has already begun.

stable enough to allow active motion. Frequently physiotherapy is started in a whirlpool tank immediately after the second dressing change. Such treatment serves two purposes: it not only increases the range of motion rapidly, but also keeps the hand much cleaner than by any other type of therapy. The primary object is to increase the flexion of the metacarpal-phalangeal joint and to obtain the maximum abduction of the thumb.

Flexion of the interphalangeal joints is no problem as long as the tendon mechanisms are intact. The fibrosis of the metacarpal-phalangeal joints, however, is usually much more severe than that involving the proximal interphalangeal joints. This fibrosis is the primary cause of limitation of motion in those patients having an intact tendon mechanism. Treatment by prolonged physiotherapy, active exercise and occupational therapy has made capsulotomy unnecessary.

An adequate range of motion of the hand and its digits of those patients who survived was accomplished within three to nine weeks following injury. This rapid re-establishment of function is due primarily to the depth of the burn; the greater the depth of burn, the more the tendon destruction and capsular fibrosis.

A full range of motion, including fully coordinated and delicate movements, was accomplished in twelve of the twenty-one hands of the patients who survived. This full range of function returned in from one to two months after injury in all but one patient; in his case the full range was not attained for more than four months because of persistent edema of the palm of the hand and digits. In those not gaining full range of motion, the range of function that was attained was adequate for writing, eating and using the hand for all but the most intricate movements. One patient had to have the interphalangeal joints fused because of the depth of his burn. Even so, he had a return of sufficient function to enable him to grasp objects of moderate size without difficulty and to write, dress and care for himself.

The length of time necessary for return of sensation in the grafted areas varied. The digits and proximal portions of the forearm or hand were the first to regain feeling. Light touch could be perceived on the fourteenth to eighteenth day after grafting, while sharp or dull sensations and temperature changes were noted after thirty days. Return of sensation was spotty, however, and even six months after grafting, those patients with deep burns had poor sharp or dull sensations and temperature discrimination.

SUMMARY

In the past year a total of twenty-seven full-thickness burns of the dorsum of the hand have been treated by early excision and grafting. Of the twenty-one hands in the surviving patients, twelve regained a completely full range of motion. In the remainder, the return of function was adequate for all but finely coordinated activity. Split-thickness grafting resulted in elastic skin coverage with no need for revision of covering of the dorsum of the hand.

Enzymatic Débridement with Activated Whole Pancreas

REGINALD W. SHELBY, M.D., LAWRENCE E. TAYLOR, M.D., ARTHUR L. GARNES, M.D. AND AARON PRIGOT, M.D., *New York, New York*

From the Department of Surgery of Harlem Hospital, Department of Hospitals, New York, New York. This investigation was supported, in part, by a grant from The VioBin Corporation, Monticello, Illinois.

THE development of enzymatic preparations for clinical use has provided a valuable adjunct in the local management of many surgical conditions. Employed topically for the débridement of stasis ulcers, decubitus ulcers, burns and infected wounds, these agents have reduced morbidity and decreased the necessity for and the extent of surgical débriding procedures.

Of primary importance in the treatment of localized infections are débridement and adequate drainage. These may be accomplished surgically or chemically by the use of enzymes. Situations arise in which it is not possible or advisable to perform adequate surgical débridement or to effect adequate surgical drainage. In many cases the digestion of necrotic tissue, eschars and purulent exudates through the selective action of the enzymes affords débridement that is not equalled by the most skillful surgical procedure. That this selective action is self-limiting both in extent and duration assures that healthy tissue and new granulations will not be disturbed.

With the enzymatic preparations surgery may often be postponed until hospital care has improved the status of the patient and reinforced his recuperative powers. There is also the consideration that a patient who has suffered such trauma as a severe burn is seldom in condition, from a systemic standpoint, for immediate surgical intervention.

In previous reports we have documented our experience with various enzymatic agents, antibiotic preparations and methods of application in the topical treatment of wounds of different types [1–4].

In our management of such cases the local treatment does not alter the total care of the patient. Infection, anemia and electrolyte imbalance are combatted and the nutritional level of the patient improved. There is no neglect of sound surgical principles when operation is indicated and is warranted by the condition of the patient.

Two stages are involved in local therapy. The first consists of combined surgical and enzymatic débridement or the use of the enzymatic agent alone. The second stage provides topical antibacterial medication to insure adequate secondary healing or to prepare the area for resurfacing. Not infrequently in large wounds both stages may be in progress at the same time.

In this paper we record our observations on the effectiveness of a new enzymatic agent* in the local treatment of stasis and decubitus ulcers, second and third degree burns and infected wounds and amputation stumps. This material is prepared from whole pancreas, desiccated and defatted in the raw state. By this method the proteolytic, amolytic, lipolytic and other enzymes of the pancreas are preserved to exert their débriding action on necrotic tissues.

The pancreatic preparation was available in the form of a white powder, packaged in a plastic squeeze bottle which, on pressure, sprayed the powder over the involved area. By this technic wounds could be redressed at intervals of two or three times a week. Often

* Viokase, the pancreatic preparation employed in this study, was furnished through the courtesy of The VioBin Corporation.

the exposure or open method of treatment was feasible.

In control experiments, using animals with paired scarified lesions and some patients with more than one wound, we found that the pancreatic enzymes did not delay wound healing

TABLE 1
TYPE OF WOUND IN 125 PATIENTS TREATED WITH ACTIVATED WHOLE PANCREAS

Type of Wound	No. of Patients
Ulcers of the extremities	57
Infected wounds	36
Burns	19
Amputation stumps	10
Decubitus ulcers	3
Total	125

and remained effective in the presence of human serum and water. Side effects from topical application were minimal and consisted of transient localized pruritus reported by a few patients. There was no evidence of allergic reactions. When injected into deep sinuses, no systemic reactions were observed.

Bacteriological studies indicated that the pancreatic enzymes possess no bacteriocidal properties *per se*, although changes in microflora were found in the wounds during treatment. These may be attributed to the action of the enzymes in so altering the environment that it was not conducive to bacterial proliferation. Certain organisms, beta hemolytic streptococci and micrococci pyogenes var. aureus, were more readily eradicated, while Aerobacter aerogenes and Bacillus proteus often persisted. It is not our intention at this time to evaluate the prevalence, importance or influence of bacteria on wound healing [5]. However, we found that the continued presence of these organisms exhibited no marked influence on wound healing once all necrotic tissue had been eliminated.

A total of 125 patients were treated with the pancreatic débriding agent in the course of this investigation. The types of wounds are listed in Table 1, which records also the number of cases in each category.

The following summaries of representative cases reflect the satisfactory results achieved with this enzymatic preparation.

CASE REPORTS

CASE I. W. S. (Hosp. No. 56-6207), a forty-two year old man, was admitted to the hospital on October 22, 1956, with an ulceration of the medial aspect of the right lower leg, 9 cm. in diameter. The treatment of this patient was complicated by the chronicity of the ulceration and marked lymphedema with many thick-walled veins.

Initially treatment was undertaken to improve the general condition of the patient and to control the infection with systemic antibiotics. On December 29, 1956, local débridement with the pancreatic preparation was started. Necrotic tissue was cleared by January 17, 1957, with great improvement in the underlying tissues.

On February 28, 1957, the involved area was excised and a split-thickness skin graft was applied. This graft sloughed and a second resurfacing procedure was undertaken on March 28, 1957.

The patient's postoperative course was uncomplicated and he was discharged completely healed on June 10, 1957.

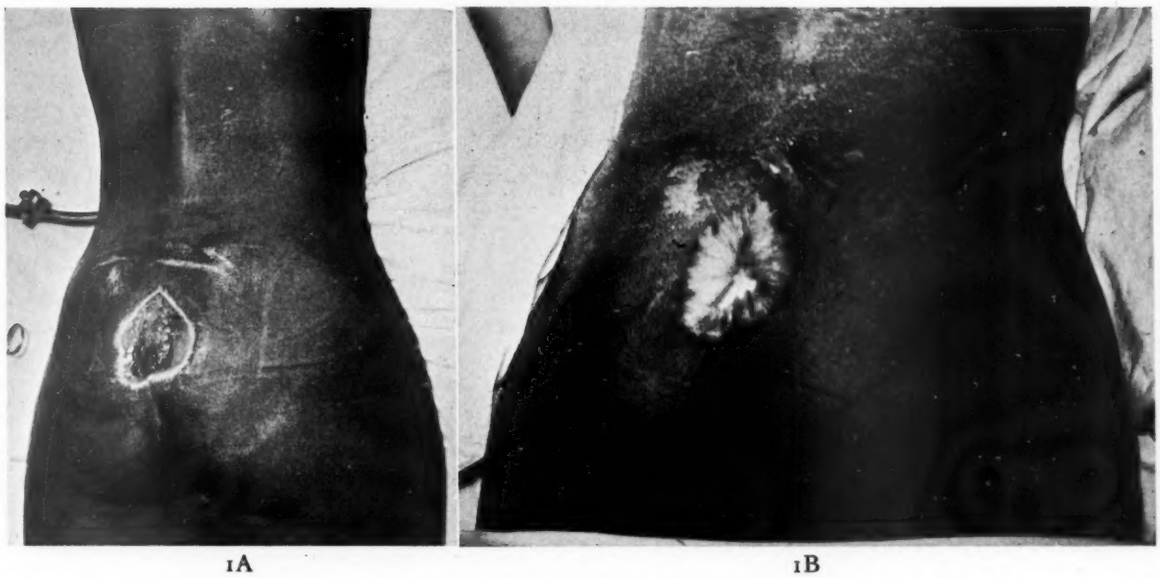
CASE II. L. S. (Hosp. No. 57-15818), a fifty-one year old man, was admitted with an infected ulcer on the anteromedial aspect of the left lower leg. The initial bacteriological culture revealed beta streptococcus, Staphylococcus aureus, proteus, aerogenes and Escherichia coli. The patient's general condition was poor with evidence of malnutrition and hypoproteinemia.

Systemic therapy consisted of antibiotics and medication to improve his nutritional status. Enzymatic débridement with the pancreatic preparation was started on December 18, 1956, and the necrotic tissue was rapidly eliminated. A repeated bacteriological study showed the persistence of beta streptococcus and aerogenes. However, healthy granulations developed by February 21, 1957, producing a suitable base for a split-thickness skin graft.

Healing progressed thereafter and the patient was discharged completely cured.

CASE III. J. B. (Hosp. No. 56-6969), a thirty-nine year old woman with diabetes, was admitted with an infected gangrenous left foot. Because of the extent of the infection, amputation of the entire foot was recommended. However, the patient refused surgery at this stage.

She received systemic antibiotics and medication for the control of diabetes mellitus. The infected ulcer on the dorsum of the foot was débrided with the enzymatic preparation with considerable revitalization of the area. On May 17, 1957, two necrotic toes were amputated and an abscess on the plantar surface of the foot was drained. A skin-grafting procedure on June 21, 1957, resurfaced



1A 1B

FIG. 1. Case VI. A, decubitus ulcer of the sacrum in a female patient with quadriplegia from gunshot wound of the cervical vertebrae. B, healing of decubitus ulcer following treatment with pancreatic preparation.

the wounds and the patient was discharged completely healed.

CASE IV. T. F. (Hosp. No. 56-16160), a thirty-five year old woman, sustained second and third degree burns of both thighs.

The burn wounds were cleared of eschar with enzymatic débridement and third degree areas were resurfaced with split-thickness skin grafts on January 12, 1957.

The patient was discharged completely healed seventy-three days after injury.

CASE V. H. deC. (Hosp. No. 56-7162), a thirty-nine year old woman, was hospitalized on May 15, 1956, for second and third degree burns of both buttocks.

Wet dressings and enzymatic débridement were employed and the sloughing areas were cleared by June 5, 1956. A skin-grafting procedure was recommended to assure healing without contracture. However, the patient refused surgery and signed out of the hospital at her own responsibility after thirty-two days. The wounds at this time were clean and granulation was progressing.

CASE VI. H. J. (Hosp. No. 57-7081), a thirteen year old girl, was admitted to the hospital following a gunshot wound of the cervical vertebrae resulting in quadriplegia. Her immobility resulted in decubitus ulcers of the elbows, occiput and sacrum. (Fig. 1A.)

The areas were débrided with the pancreatic enzymes and healed by second intention. (Fig. 1B.) The patient was thereafter transferred to a Stryker frame and is still hospitalized. There has been no recurrence of decubitus ulcers.

CASE VII. D. A. (Hosp. No. 56-11467), a thirty-nine year old man, was admitted with an infection surrounding a Lane plate which had been used in reduction of fractures of the right tibia and fibula. A sinus tract was present.

The pancreatic preparation was employed for débridement and instilled into the sinus tract. Enzymatic therapy was continued for two weeks, with control of the infection and progressive healing.

CASE VIII. G. C. (Hosp. No. 54-19557), a forty-eight year old man, was seen in the clinic, complaining of ulcers of both lower legs of three years' duration. The ulcers were on both the inner and outer aspects of the legs (Fig. 2A and B), with extensive necrosis.

The patient was admitted to the hospital and on December 1, 1954, local débridement was started with the pancreatic enzymes. By December 8th necrotic tissue had been eliminated and healthy granulations appeared. (Fig. 2C and D.)

The patient was discharged on December 27, 1954, with healing well progressed.

CASE IX. C. S. (Hosp. No. 57-2807), a forty-seven year old man, was admitted for injuries sustained when an elevator descended on his bare feet. The left forefoot was traumatically amputated and there was an extensive avulsion of the skin over the dorsum of the right foot. Culture of the wounds revealed Staph. aureus.

2A

2B

2C

2D

FIG. 2. Case VIII. A and B, December 1, 1954. Ulcers of both lower legs of three years' duration, prior to enzymatic débridement. C and D, December 8, 1954. Post-treatment, necrosis eliminated and healing progressing.

The traumatically amputated portion of the left foot was revised surgically and the avulsed skin of the right foot débrided. Systemic antibiotics were administered and residual débridement was accomplished postoperatively with the enzyme preparation. Skin grafts were applied to both wound areas with subsequent progressive complete healing. After a total of 126 days of hospitalization the patient was discharged to a rehabilitation hospital.

SUMMARY

Our experience in 125 cases of infected wounds, amputation stumps, stasis and decubitus ulcers, and second and third degree burns indicated the clinical effectiveness of pancreatic enzymes for débridement in the local management of these conditions.

In animal experiments the preparation did not interfere with wound healing and its activ-

ity is maintained in the presence of water and human exudates.

As packaged in a squeeze bottle spraying a powder, it is easily applied, is effective in the open treatment of wounds and facilitates the management of patients on an ambulatory basis.

Morbidity in these cases was reduced considerably and enzymatic débridement could be undertaken when the patient's condition did not warrant formidable surgical débridement.

Although the pancreatic enzymes have no bactericidal properties, bacterial flora were controlled by denial of a suitable substrate for proliferation. Many organisms were thus eliminated.

The foul odor characteristic of infected wounds disappeared almost completely. Necrosis and purulent exudates were eliminated. The wounds became clean, with healthy granulation tissue, and the areas thus revitalized were closed through progressive healing or by surgical resurfacing.

CONCLUSION

The pancreatic enzyme débriding agent, prepared as desiccated whole pancreas in powder form, is a valuable adjunct in the management of infected wounds.

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Device for Expediting Skin Grafting of Extremities

PHILIP JACOBSON, M.D., *Petersburg, Virginia*

SKIN grafting is sometimes a long and tedious task. When large or irregular areas are to be covered, the operation often cannot be finished in one stage because of factors beyond the surgeon's control. The lack of adequate assistance in small hospitals or hospitals in small towns which have few or no internes also can be a hindrance. Further procedures will be required and the hospital stay prolonged. Under these circumstances, a device which reduces the operating time or enables the surgeon to accomplish more at each session would be useful.

The principal difficulty is holding the grafts in position until suturing is completed or the grafted area has dried. Figures 1 through 4 portray a simple device by which the whole area can be covered and the grafts held securely for either method. The grafts are transferred as soon as they are taken, hence the operator is not likely to remove too much or too little skin.

FIG. 1. The grafts have been taken and immediately transferred to the open wound, drawn under the ties with mosquito clamps, and then spread out into position.

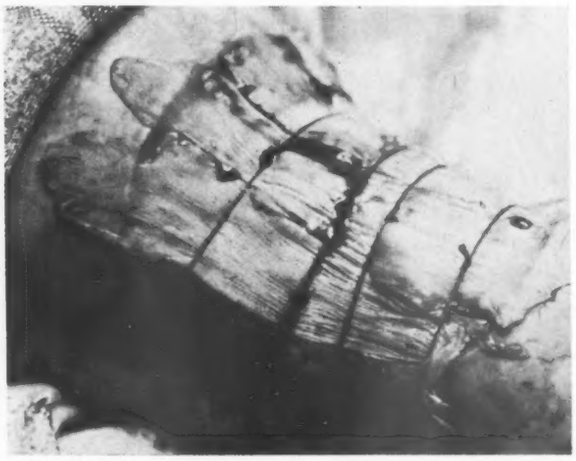


FIG. 2. The wound has been covered and excess skin can be removed. The grafts could have been left as they were until dried. The strips to cover this wound should have been wider but were purposely made narrow for illustrative purposes.

The device consists of applying ties of No. 0 or No. 1 silk, 1 or 1½ inches apart along the denuded area. The ties need to be only tight enough to prevent movement up and down and to permit the grafts to be slipped under them. At first rubber bands were used but these rolled too easily and their elasticity affected the circu-

FIG. 3. The ties have been removed. A mechanic's waste dressing was applied because this wound was on a dorsal surface of the leg and there was the possibility, while the patient was on her back, that she would injure the grafts before they had become firmly attached.

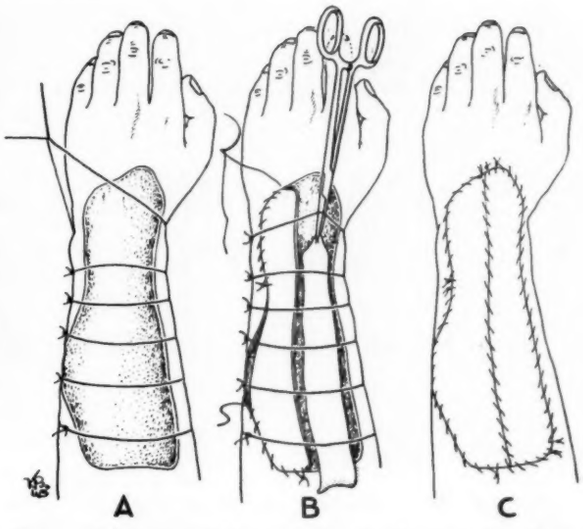


FIG. 4. Diagram of the technic. A, the area has been prepared for the grafts and the ties are put in place. B, the grafts are passed under the ties, using mosquito clamps and, when the area is covered, are securely held while being sutured. C, the ties are removed.

lation. Moreover, circumferences along extremities vary considerably and too many sizes were required.

In my experience, this device simplifies the procedure and reduces the operating time at least one-half. Only the assistance of a nurse is required. It does not alter in any way the surgeon's usual technic. Two operators can suture at the same time without one interfering with the other.

Selective Bronchial Suction Catheters and Their Clinical Application

EDWARD ERNEST ROCKEY, M.D. AND SAMUEL ALCOTT THOMPSON, M.D., *New York, New York*

From the Department of Thoracic Surgery, Metropolitan Hospital, New York, New York.

ALTHOUGH bronchial catheters were already developed over a hundred years ago [1], tracheobronchial catheterization became easily applicable and effective only with Thompson's work [2,3], reported over two decades ago. The Thompson bronchial catheters are radiopaque, semirigid and curved at their tip. Under indirect laryngoscopic vision, they can be inserted into the trachea easily. Because of their curved distal end, they can be advanced from the trachea into the primary and secondary bronchi of the lungs without difficulties. The direction of the tip of these catheters is known to the operator because the notched outer end moves with it. The great diagnostic and therapeutic possibilities of these catheters are very well known to all who have learned to use them. The familiarity of the nature and uses of the Thompson catheters for the past sixteen years has led to catheter designs for newer needs, such as tracheal fenestration [4,5].

DESCRIPTION

The evolution of the selective bronchial suction catheters (Fig. 1)* grew out of the need for adequate suctioning equipment and technic in patients with tracheal fenestration. This operation is performed primarily on patients with advanced suppuration and cases of emphysema with or without clinically obvious suppuration or increased and retained bronchial secretion requiring thorough and repeated tracheobronchial suctionings. The present catheters are also semirigid, radi-opaque, and their tips are curved in an almost 90 degree angle. There is a nodule near the outer end which is on the same side as the tip. When the outer end of the catheter is turned, the tip remains always on the same side as the nodule. Some of the catheters are calibrated in centimeters starting at a distance of 26 cm. from their tip, others for their entire length. In the

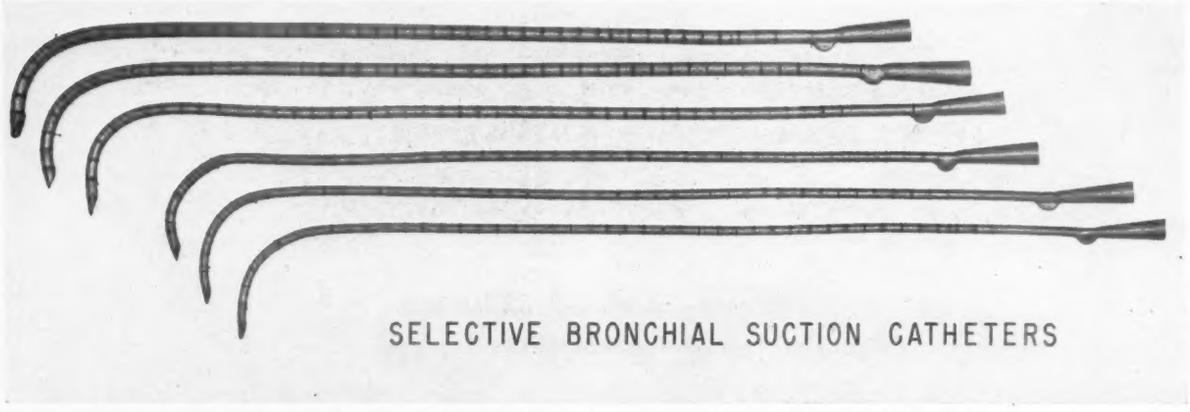


FIG. 1. A series of selective bronchial suction catheters, ranging in size from Nos. 14 to 22 French.

* Made by C. R. Bard & Co., Summit, New Jersey.

human being, this 26 cm. distance represents an approximate measure from the teeth to the main carina. The knowledge of this distance is a help when the catheters are inserted through the oral route. These suction catheters come in sets of five or six and their sizes are: Nos. 14, 16, 18, 20, 22, and 24 French. (Fig. 1.)

right middle lobe, 5 cm. The bronchus of the left upper lobe comes off to the left of the main carina with its orifice located slightly upward and anteriorly. The bronchus of the left lower lobe comes off to the left of the main carina with its orifice located slightly downward and posteriorly. The approximate distance from

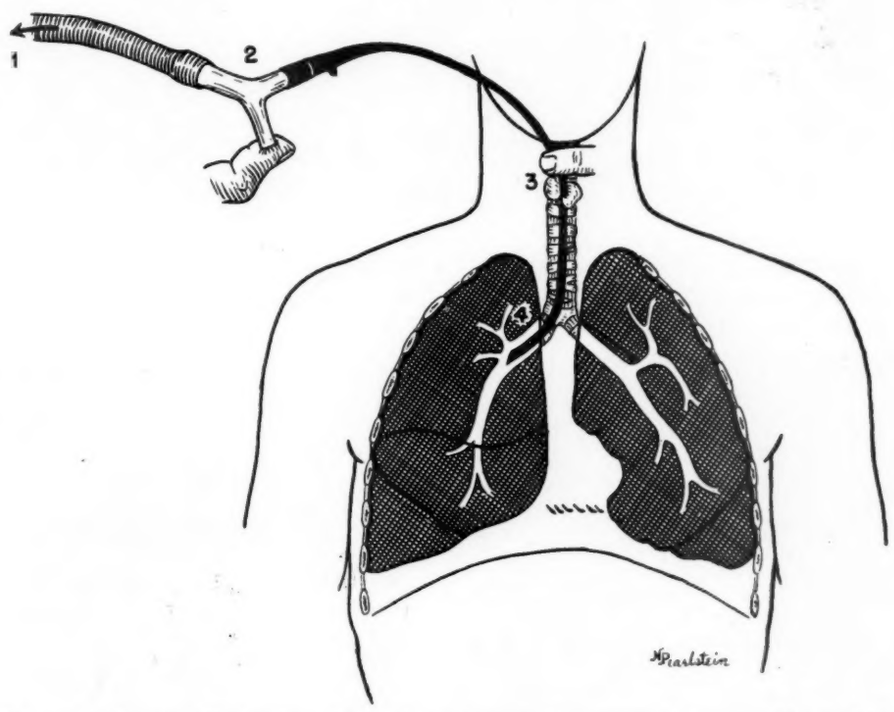
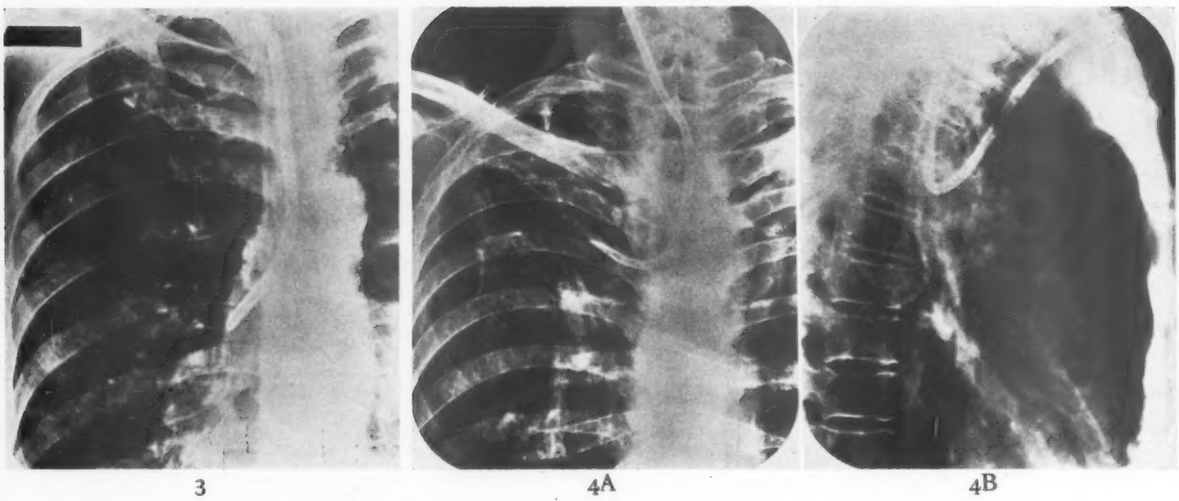


FIG. 2. A drawing illustrating the suction setup: suction source (1), connecting tubing with Y glass tube occluded (2) by the operator's thumb (the suction circuit is closed) and the selective bronchial suction catheter is already inserted through the fenestration (3) and its tip is in position for suctioning (4).

SUCTIONING TECHNIC

Knowing the directions of the bronchial orifices is necessary in order to be able to insert these catheters into the designated lobes and segments. Insertion of these catheters into only the right and left primary bronchus requires no particular knowledge of the tracheobronchial anatomy. This makes their use possible even by a less intelligent patient. It is enough to remember that the bronchus of the right upper lobe comes off to the right, the bronchus of the right middle lobe, anteriorly, and the bronchus of the right lower lobe is a straight continuation of the right main bronchus. There are very few exceptions to these directions. The approximate distance from the carina to the bronchus of the right upper lobe is 2 cm., to the bronchus of the

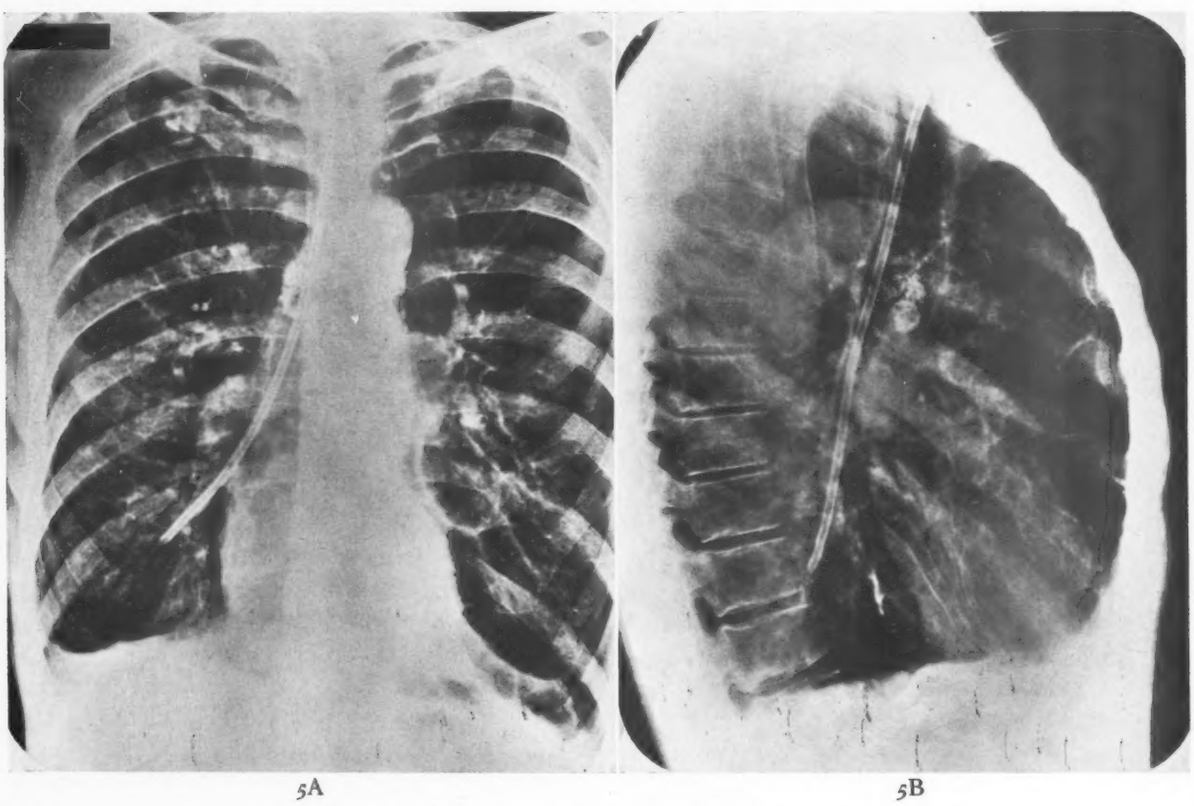
the main carina to the left upper and lower lobe orifices is about 5 cm. Through the tracheal fenestration (which is about 9 to 10 cm. distance from the main carina), the selective bronchial suction catheters can be easily inserted into the trachea and then advanced into the primary, secondary and even tertiary bronchi by the physician, nurse, or patient. A Y glass tube connects the suction catheter with the suction source and trap bottle. About three to four minutes after the insertion of 1½ to 2 cc. of ½ per cent pontocaine® hydrochloride through the tracheal fenestration, suctioning of the tracheobronchial tree is started. First the No. 24 or 22 F. sized catheter is inserted into the right primary bronchus by turning its tip to the right side of the patient just before insertion



3 4A 4B

FIG. 3. Posteroanterior x-ray film of the chest showing suction catheter in the right main bronchus.

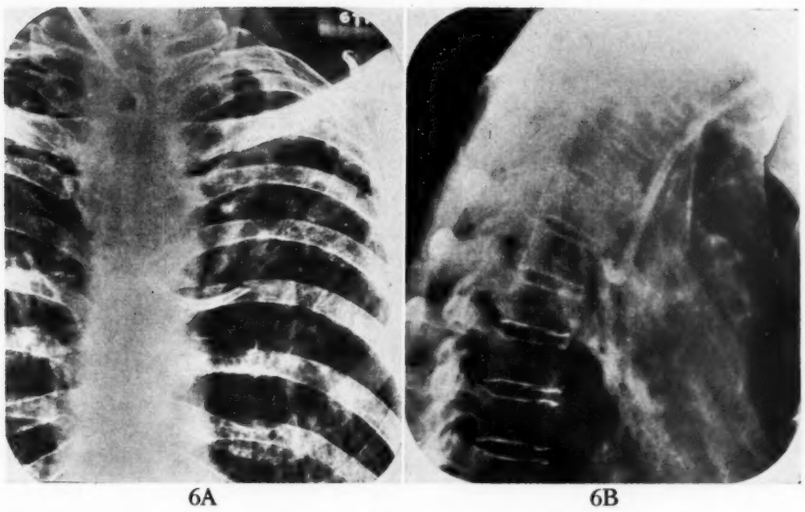
FIG. 4. Posteroanterior (A) and right lateral (B) x-ray films of the chest showing the suction catheter in the posterior segment of the right upper lobe.



5A 5B

FIG. 5. Posteroanterior (A) and right lateral (B) x-ray films of the chest showing the suction catheter in the posterior basal segment of the right lower lobe.

between the opposing valves of the tracheal fenestration. Then the catheter is advanced for about 11 to 12 cm. before its tip is directed in the order of listing toward the upper, middle and lower lobe bronchial orifices. After suctioning the right lung, the same catheter is inserted into the left primary bronchus by holding it in such a way that the tip points to the left of the patient just before insertion between the opposing valves of the tracheal fenes-



6A 6B

FIG. 6. Posteroanterior (A) and left lateral (B) x-ray films of the chest showing the suction catheter in the left upper lobe.

tration. Then with the catheter kept in the same position, it is advanced to about 13 to 14 cm. At this stage of the catheter insertion, its tip will be in the left primary bronchus. The next step will be direction of the tip towards the left upper, lingular, and lower lobe bronchial orifices. The catheter is inserted each time as far as it will go, then pulled back about ¼ to 1 inch distance before the operator's finger is placed over the open end of the Y glass tube, creating a closed suction circuit. (Fig. 2.) The catheter must be pulled out completely and its lumen washed with sterile water as often as the lumen is filled or becomes occluded by bronchial secretion. When this serial suctioning plan (Figs. 3 through 8) is completed with the largest catheter, it is followed up by the same serial insertions of one or two of the smaller sized catheters in the same manner as outlined, thus allowing not only lobar, but also segmental bronchial suctionings.

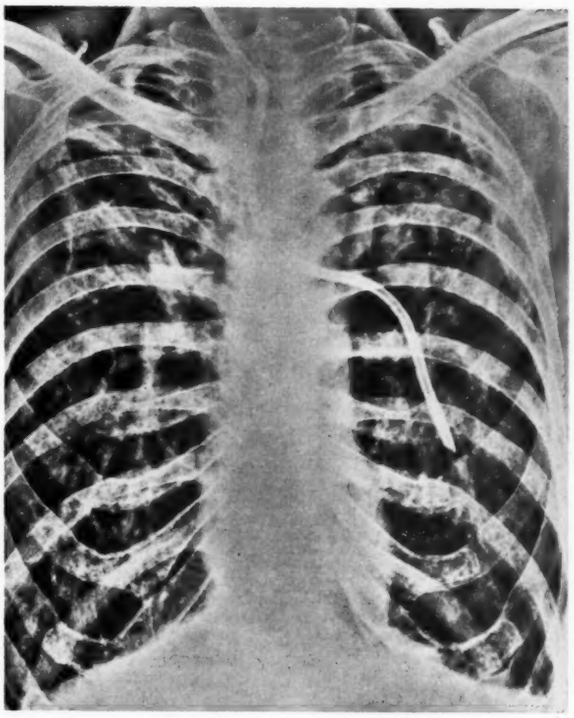
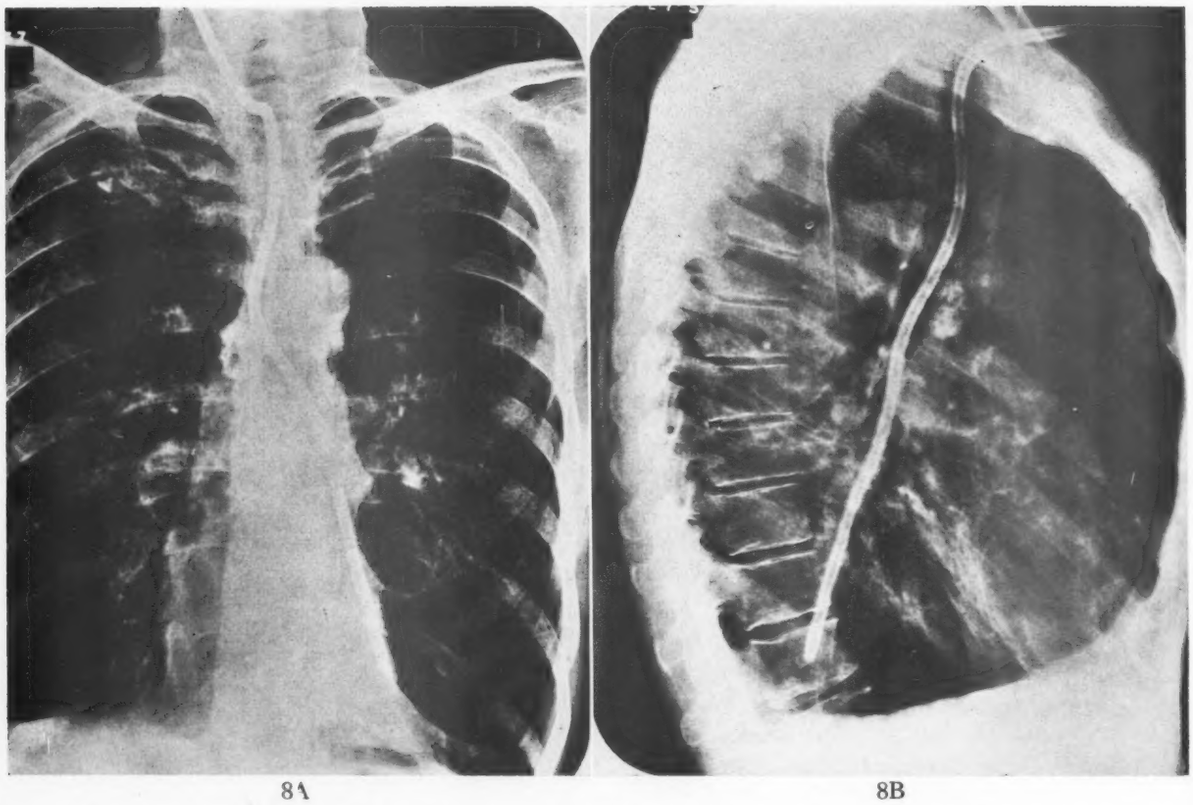


FIG. 7. Posteroanterior x-ray film of the chest showing the suction catheter in the lingula.

COMMENTS

The selective bronchial suction catheters were utilized for suctionings in all our patients with tracheal fenestration, and also in patients with only tracheostomy. These catheters are also of great help to the anesthesiologist, who can insert them through the endobronchial tube, already in place, during anesthesia, for the purpose of selective suctioning of the right or left lung or their subdivisions, as desired. Suctioning experience proved that when the tracheobronchial tree appears to be dry, the use of a smaller, or the smallest, selective bronchial catheter will result in additional elimination of bronchial secretion. This is accomplished because a smaller catheter reaches further into the periphery of the tracheobronchial tree than a larger one. This is the reason the catheters were designed to come in sets and various sizes



8A 8B

FIG. 8. Posteroanterior (A) and left lateral (B) x-ray films of the chest showing the suction catheter in the posterior basal segment of the left lower lobe.

from Nos. 14 to 24 F. Availability of such a set makes it possible to utilize two or three catheters at each suctioning session. The size to be selected in each case depends on the age and size of the patient. These catheters were found to be of utmost help in the following conditions: advanced pulmonary tuberculosis with excessive drainage, cystic fibrosis of the pancreas with excessive pulmonary manifestations, generalized bronchiectasis with advanced emphysema, clinically dry advanced emphysema, and finally, advanced emphysema with suppuration or with clinically obvious increased bronchial secretion [6,7], and the so-called hyalin membrane syndrome.

SUMMARY

A report on a new set of selective bronchial suction catheters is presented. They were designed specifically for patients with tracheal fenestration but can be used equally effectively on patients with tracheostomy. The value of these catheters to the anesthesiologist for selective suctionings through the conventional endotracheal tube during anesthesia is also emphasized.

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Successful Microdermagrafting Using the Meek-Wall Microdermatome

C. Parker Meek, M.D., *Aiken, South Carolina*

Microdermagrafting is not a new concept. Many attempts have been made using different methods and technics. Up to the present time no practicable application of this method has been made. If a piece of split-thickness skin is placed upon a recipient area, the transplant grows from the periphery outward. On the basis of this statement, it follows that the ideal for re-epithelizing a denuded area in a minimum amount of time is to provide the greatest possible growing margin to the area. To determine the growing surface of a square piece of skin, it is necessary simply to obtain the sum of the four margins, e.g., a 1 inch square yields a 4 inch growing margin. If this original square is cut into successively smaller squares, the available growing margin increases by geometric progression, e.g., a 1 inch square cut into four smaller squares yields 8 inches of margin; when each of the four smaller squares is cut into four still smaller squares, the original 1 inch square yields 16 inches of growing margin. If 256 squares are made from each square inch, 64 inches of lateral growing surface are obtained. This demonstrates the well known principle that the smaller a body is, the greater is its surface in relation to its volume.

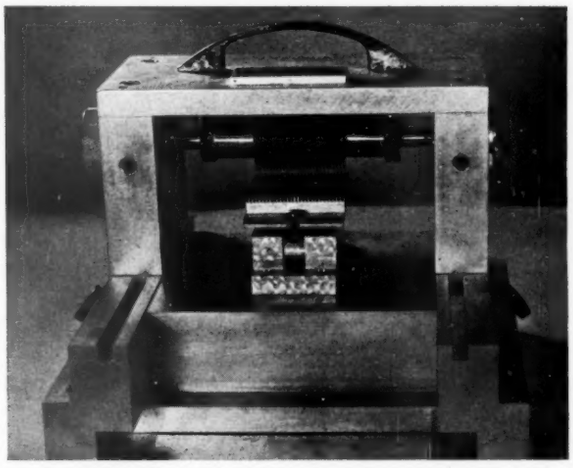

Fig. 1. The Meek-Wall microdermatome shown in its cutting position. The cutter is driven by an electric motor.

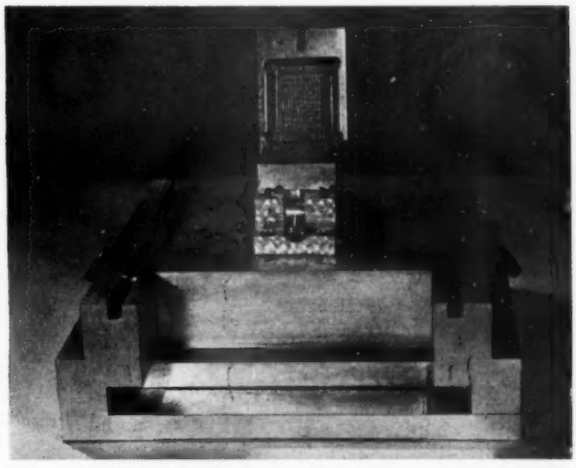

Fig. 2. The Meek-Wall microdermatome showing the grill raised. The split-thickness graft is placed on the cork pad and is held in place by the grill for cutting. After one cut is made the cork is turned 90 degrees and the second cut is made, completing the procedure for cutting the small squares.

Thus it is obvious that a technic which makes the maximum application of this principle is a desirable contribution to the field of skin grafting. The case often arises in which the need for skin is great but the size of the donor site is small.

CASE REPORT

D. J., a fourteen year old girl, was admitted to the Aiken County Hospital on January 17, 1958, with burns involving approximately 25 per cent of the total body surface. Most of the burned areas were on the abdomen, thighs and hands.

Minor débridement was performed in the emergency room and the entire burned surface was covered with dermaplast. No other dressings were applied at this time. Dermaplast was used as needed until general débridement was performed ten days later in the operating room with the patient under general anesthesia. After this débridement furacin® dressings were applied. Microdermagrafting was performed on February 1, 1958.

The following technic was used for the microdermagrafting:

Conventional split-thickness grafts of .0125 inch were taken with a Stryker rolodermatome and these grafts were recut with the Meek-Wall microdermatome into units 1/16 inch square. (Figs. 1 and 2.) The microdermagrafts were put in plasma and then distributed directly to bandages made from parachute silk. These bandages were inverted and placed onto the burned area. Furacin pressure dressings were applied on top of the parachute silk. The bandages were removed for the first time on the fifth postoperative day and the burned areas were redressed with furacin dressings. After ten days no further changing of bandages was done and the grafted areas were left exposed.

CONCLUSIONS

1. Microdermagrafting can be performed successfully on human beings and this technic can be applied in treating the badly burned patient.

2. The Meek-Wall microdermatome recuts conventional split-thickness grafts into the desired smaller units without devitalization of the tissue.

3. A more satisfactory technic for applying the microdermagrafts can be worked out.

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Enchondroma of the Sternum

A. LINCOLN BROWN, M.D. AND CAPT. WILLIAM C. BARRETTE, M.C., U.S.A.,*
San Francisco, California

From the Surgical Service, Mount Zion Hospital, San Francisco, California.

ENCHONDROMA of the sternum is a rare cartilaginous tumor. In 1932, Heuer [1] collected thirty-eight cases of tumor of the sternum, only five of which were chondroma. Subsequently, Hedblom [2], reporting on 313 tumors of the bony chest wall, included only one case of chondroma of the sternum. Sommer and Major [3], in 1942, reported two additional cases, and in 1946, Santy, Dargent, and Marion [4] added another case to the literature. In 1947, Kinsella, White, and Koucky [5], in a review of the literature as far back as 1873, found eleven cases of chondroma of the sternum, including six cases not listed by the previously cited authors. In 1949, Geschickter and Copeland [6], reported six cases from their personal experience with over 500 tumors of bone. In 1951, O'Neal and Ackerman [7], in a study of ninety-six cartilaginous tumors of the ribs and sternum, listed only eight sternal chondromas in their table of benign tumors, including a case described earlier in 1939 by Head, which had not been mentioned by the previously cited authors. In 1955, Matisseck and Wilhelm [8] reported two cases of sternal chondroma, one of which was diagnosed on the basis of clinical and roentgenological evaluation without histological confirmation. We believe that the rarity of this tumor warrants the report of the following case with a seven year follow-up period.

CASE REPORT

The patient, F. P., was a forty-eight year old white male investment broker, who was admitted to the Surgical Service of Mount Zion Hospital on May 21, 1951, with a chief complaint of pain in the chest of ten weeks' duration. The pain, dull and aching in character, occurred over the upper anterior part of the chest, and was worse at night although it did not interfere with his sleep. Past

FIG. 1. Preoperative roentgenogram demonstrating expansive sternal tumor.

* Present Address: Orthopedic Service, 5th General Hospital, APO 154, New York, N. Y.

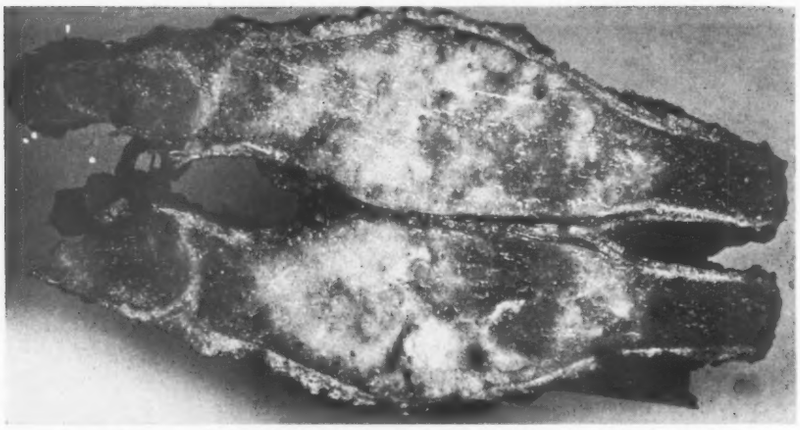

FIG. 2. Split gross specimen clearly showing limits of tumor extension.

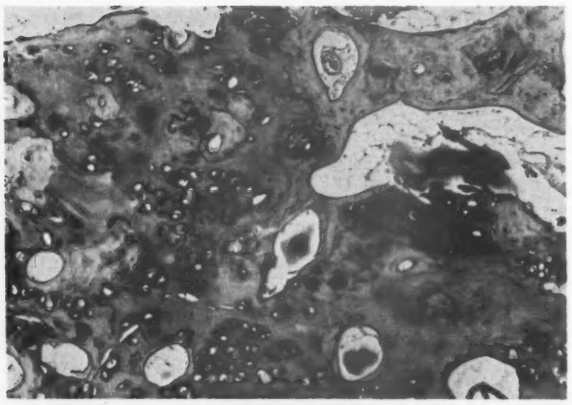

FIG. 3. Microscopic section showing histologically mature characteristics of cartilaginous tumor.

history revealed that the patient had had a duodenal ulcer, demonstrated on upper gastrointestinal series one year prior to admission; this ulcer had since responded favorably to an ulcer regimen, both symptomatically and roentgenologically. Physical examination revealed a well developed, well nourished, white man in no distress. Vital signs were within normal limits. Skin was clear. There was no lymphadenopathy. There was a 3 cm. irregular, slightly tender elevation over the body of the sternum. The liver was felt 1 cm. below the right costal margin, and there was slight tenderness in the left lower quadrant of the abdomen. Neurological examination and the remainder of the physical examination were within normal limits.

Complete blood count, urinalysis, and Kline serologic test were negative. X-ray films of the chest showed a cystic, expansile tumor of the body of the sternum, with bone and calcification. (Fig. 1.) Also, a review of the gastrointestinal series taken one year prior, showed the sternal tumor to be present at that time. Preoperative diagnosis was osteogenic sarcoma.

On May 22, 1951, under N_2O, curare, pentothal,® and cyclopropane anesthesia, with the usual preparation and draping of the patient, a curved incision was made, with the convexity to the left, beginning from the sternomanubrium junction and extending to the ensiform process. This incision was carried through the skin and subcutaneous tissues, and bleeders were clamped and coagulated with the Bovie unit. The right skin flap was then dissected free, and the pectoralis muscles, as they came together to insert on the sternum and ribs, were separated in the midline, and cleaned off the sternum and medial aspect of the ribs at their insertion on the sternum by blunt and sharp dissection. The tumor mass was then identified, extending from the lower border of the sternum up to the area where the third rib joins the sternum. It did not involve the periosteum, costal cartilages or overlying pectoral muscle. The sternum was then exposed from the area superior to the second rib, to the ensiform process and laterally to just beyond the costal cartilages. The under surface of the sternum and rib margins, from the third rib down were freed, and the costal cartilages divided. The sternum was freed from the underlying tissue of the mediastinum and pleura, and in so doing, a small tear in the right pleura was accidentally made. The sternum was then divided just below the articulation of the second rib with the sternum, using a Gigli saw, and removed along with the ensiform process. Examination of the specimen revealed that grossly there was no extension down these areas. The rent in the pleura was then approximated, using No. 00 plain catgut sutures. Hemostatis was good. The defect in the chest wall was partially obliterated by approximating the pectoralis muscles, using interrupted No. 00 chromic catgut figure of eight sutures. A small catheter was placed as a drain beneath the pectoralis muscles and sutured to the skin. A fish mouth finger cot was placed over the opening. The subcutaneous tissue was then approximated with No. 3-0 plain catgut and the skin closed with silk. A dressing was applied and a plaster roll used over the anterior part of the chest

to cover the defect was held in place with elastoplast and tape. The patient was returned to the ward in good condition.

The gross pathological specimen (Fig. 2) consisted of a sternum with short rib stubs and costal cartilages. The sternum, measuring 11.5 by 2 cm., was cut longitudinally down the center. The marrow of the sternum was replaced and distended by firm whitish material, representing an ovoid, greyish-white tumor mass, measuring 6 cm. in length and 2.5 cm. in smaller diameter.

The microscopic sections (Fig. 3) showed the sternal marrow spaces to contain large sheets and islands of mature appearing cartilage. The cartilage was contained within the medullary canal, and in these sections, the cartilaginous islands were usually limited by the cortex. However, at several points the cartilage was surfaced by extremely thin cortex or just periosteum. The cartilage cells occurred in two's and three's and were not histologically atypical. At the longitudinal margins and scattered between the cartilage cells were the remains of cellular bone marrow. Diagnosis was enchondroma of the body of the sternum.

COMMENTS

Although this patient shows no recurrence after seven years, the possibility of further difficulty exists, because of the proclivity of cartilaginous tumors of the chest wall (even though histologically benign) to recur after treatment, and also because of the potentiality of these tumors to undergo change to chondrosarcoma. Many cases on record are characterized by frequent recurrences after treatment or by a frank malignant change. Indeed, Geschickter and Copeland [6] cited a case of benign chondroma of the sternum which became malignant fifteen years after treatment with radium.

It is also true, however, that many of these tumors are underdiagnosed at the onset, so that what was believed to have been a malignant change in a previously benign tumor, in some instances, was in reality, a malignant tumor from the beginning. O'Neal and Ackerman [7], in their study of cartilaginous tumors of the chest wall, expressed doubt as to the benign character of several of the cases they listed, due to the apparent malignant course assumed by these particular tumors. Graham [9] believes that most of the tumors of the bony chest wall are malignant.

This statement is supported by the preponderance of malignant tumors found in the studies of large numbers of chest wall tumors, particularly those of Hedblom, and of Heuer, previously mentioned. The criteria for differentiating benign and malignant tumors have been set forth by Jaffe and Lichtenstein [10]. Although the histological characteristics of the tumor reported in this case study satisfy the criteria for a benign tumor, due to these considerations the prognosis must remain guarded.

SUMMARY

A case of chondroma of the body of the sternum without recurrence after seven years is reported and the rarity of this tumor indicated. In addition, it is emphasized that these tumors often recur after treatment and are prone to undergo change to chondrosarcoma. Surgery consists of wide sternal excision.

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Hiatal Hernia with Gastric Occlusion and Intrathoracic Perforation of Gastric Ulcer on the Greater Curvature

SEYMOUR FISKE OCHSNER, M.D. AND ALTON OCHSNER, M.D., *New Orleans, Louisiana*

From the Departments of Radiology and Surgery, Ochsner Clinic, New Orleans, Louisiana.

HERNIATION of a portion of the stomach through the esophageal hiatus in the diaphragm occurs fairly often, and its complications have been widely recognized [*1–8*]. Benign

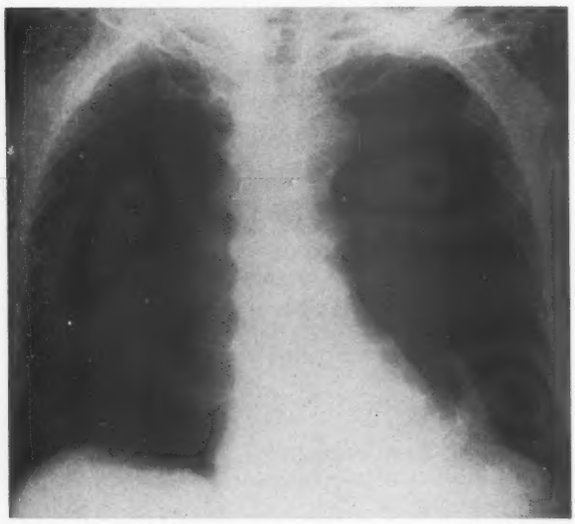

FIG. 1. Frontal roentgenogram of chest. Note hiatal hernia as air-containing mass behind heart.

gastric ulcers are likewise fairly common, and their occurrence on the greater curvature of the stomach is being more frequently recorded [*9–11*]. The following case is believed to be the first recorded instance of an ulcer on the greater curvature of the stomach in a hiatal hernia. The case is doubly interesting because gastric occlusion occurred and the ulcer perforated intrathoracically; prompt surgical excision cured the patient.

CASE REPORT

A seventy-nine year old housewife was admitted to Ochsner Foundation Hospital on November 30, 1955, with complaints of severe nausea and vomiting. She had had occasional episodes of vomiting for years, and in 1952 a diagnosis of hiatal hernia had been established by roentgenologic examination. During the preceding few months her symptoms had gradually become worse, and the hiatal hernia was demonstrably larger radiographically. During the week before admission she had had persistent nausea and had repeatedly vomited blood.

On admission the patient was emaciated, extremely dehydrated and acutely ill. Severe electrolyte imbalance was indicated by elevated serum sodium (156.1 mEq./L.) and lowered serum potassium (2.3 mEq./L.). Carbon dioxide capacity was 26 mM/L. and chloride was 103.7 mEq./L. Hemoglobin was 16.9 gm. per cent and hematocrit was 50 per cent.

On roentgenologic examination of the chest, the heart and lungs appeared normal. A density with central radiolucency behind the heart was suggestive of a large hiatal hernia. (Fig. 1.) Gastrointestinal roentgenologic examination on the day of admission was difficult and abbreviated because of the patient's condition and bloody vomiting. It did show the presence of a peculiar type of hiatal hernia. The stomach appeared to be rotated as well as inverted in a large herniated pouch and obstruction was complete in the antral portion that was above the diaphragm. (Fig. 2.) The gastric wall was irregular and a vaguely defined marginal outpocketing suggested a possible ulcer crater.

Medical management resulted in prompt improvement and the patient was prepared for operation. On December 3, 1955, a sudden, severe, steady pain developed in the left upper abdominal quadrant, extending to the back and shoulder. The pain was aggravated by breathing. Prompt surgical

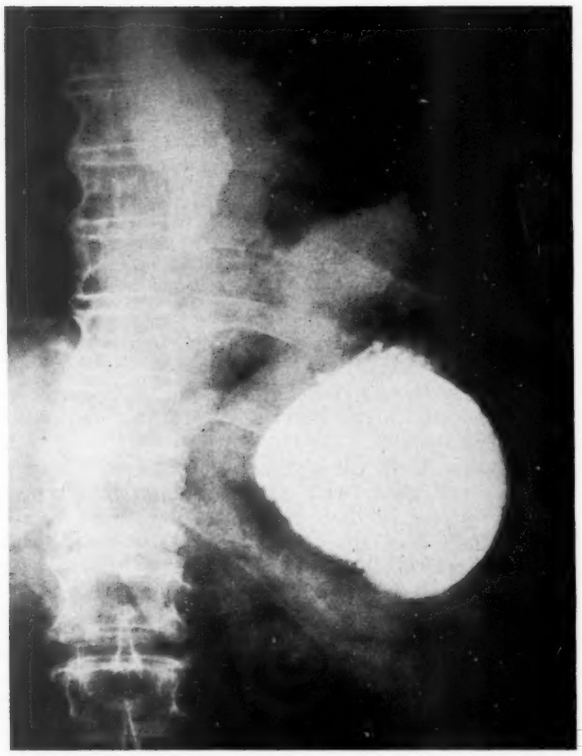

FIG. 2. Roentgenogram taken two hours after ingestion of barium. Note barium in esophagus and fundus of stomach. No barium passed from fundus of stomach into that portion which lies above the diaphragm.

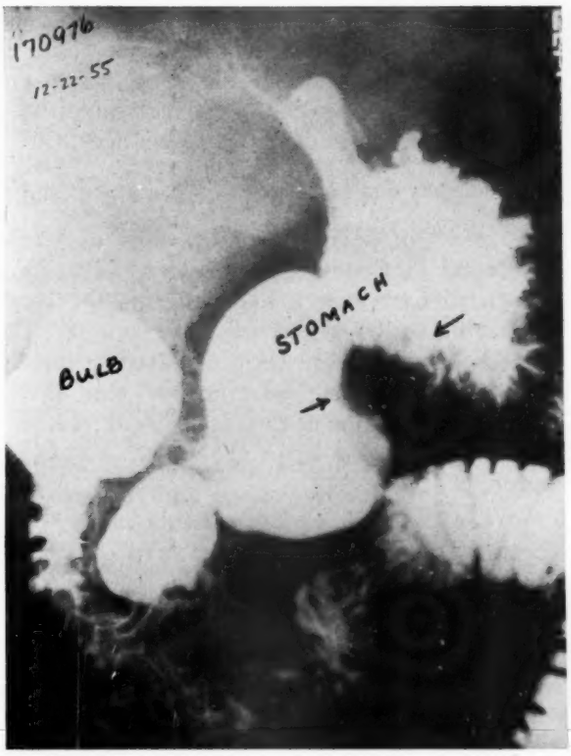

FIG. 3. Gastrointestinal roentgenogram taken postoperatively. Note all of stomach is now below diaphragm and defect in greater curvature of stomach as a result of wedge resection of ulcer.

therapy was instituted. A large amount of fluid was found in the right pleural cavity, as a result of perforation of the gastric ulcer through the hernial sac. The gastric ulcer was on the greater curvature of the stomach. The ulcer-bearing segment was resected, the hernial sac excised, the stomach mobilized and replaced into the abdomen, and the diaphragmatic hernia repaired.

On pathologic study the gastric ulcer proved to be benign and measured 1 cm. in diameter. The excised portion of the stomach measured 4 by 2.5 cm.

Postoperative recovery was surprisingly prompt, complicated only by the pleuritis and apparently moderate atelectasis and pneumonitis which developed in the right lung. This subsided within one week. Roentgenography of the gastrointestinal tract on December 22, 1955, showed only the postoperative defect involving the greater curvature of the stomach. (Fig. 3.) A small duodenal diverticulum was also noted. The patient was discharged December 22, 1955, and has remained well since.

COMMENTS

Several features of this case deserve comment. The hiatal hernia had been discovered several years before the onset of serious complications. All physicians treating patients with hiatal hernia should realize that serious complications may develop suddenly in these patients. Our patient had four of the more important complications that may ensue: ulceration, hemorrhage, obstruction and perforation. That she survived all of these despite her age is gratifying.

Blades and Hall [8] mentioned the extremes of opinion of the roentgenologist and surgeon regarding this condition. The former, discovering many hiatal hernias incidentally during gastrointestinal examination, is apt to minimize their importance, whereas the surgeon may see only the complicated cases and assumes that the condition is usually serious. An attitude between these extremes seems reasonable. A small, symptomless herniation probably should be considered as generally unimportant. Minor symptoms may be improved by diet and reduction of the obesity which is usually present. Surgical repair should be considered if a hiatal hernia is associated with definite symptoms, such as pain or troublesome regurgita-

tion; if successive roentgenologic studies show that the herniation is enlarging; if there is evidence of ulceration in the herniated stomach; if there is unexplained hemorrhage; or if there is evidence of obstructive changes.

SUMMARY

A series of severe complications suddenly developed in a seventy-nine year old woman known to have had a hiatal hernia for three years. These consisted of ulceration of the greater curvature of the herniated stomach, hemorrhage, gastric obstruction and intrathoracic perforation of the ulcer. Local resection of the stomach and repair of the hernia resulted in cure.

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Mesenteric Vascular Occlusion

WILLIAM F. HOLSEY, JR., M.D., *Whipple, Arizona*

From the Surgical Service, Veterans Administration Center, Whipple, Arizona.

Two cases of mesenteric vascular occlusion were surgically treated with success within the past year at the Veterans Administration Center, Whipple, Arizona. In both there was mesenteric venous obstruction, one involving the inferior mesenteric vein, and the other the superior mesenteric vein.

CASE REPORTS

CASE 1. A. R. S., a forty-one year old white man, was admitted on September 13, 1956, with ulcers of both feet of four weeks' duration, and thrombophlebitis of both legs of approximately three months' duration resulting from trauma.

In 1943, while in New Guinea, the patient had scrub typhus, malaria and pneumonia followed by thrombophlebitis of both legs. Recurrent varicose leg ulcers required short hospitalizations in 1946 and in 1952. In 1947 he underwent left saphenous vein ligation and left lumbar sympathectomy. The patient has smoked heavily for many years.

On physical examination positive findings included a bilaterally diminished femoral and popliteal pulsation, more marked on the right. The muscles below the knee of both legs were slightly atrophic. There was bilateral thrombophlebitis of the superficial vein, more marked on the right, with a tender ulcer in the medial aspect of each ankle and 1 to 2 plus edema of the legs.

Routine tests, prothrombin time and platelet count were normal.

On conservative medical therapy without anticoagulants, the bilateral thrombophlebitis subsided and the ankle ulcers healed. On November 5, 1956, right axillary vein thrombosis suddenly developed. He was given tetracycline and heparin; the dosage of heparin was increased to 150 mg. every six hours to achieve an adequate coagulation time response. Three days later left pleuritic pain and a cough productive of blood-tinged sputum developed, and chest x-ray was suggestive of pulmonary infarction. On November 12, over a period of several hours, grossly bloody diarrhea and crampy abdominal pain developed, as well as progressive lower abdominal tenderness with a questionable mass in the left lower quadrant and a silent abdomen. Although the temperature, blood pressure and pulse were initially normal, the latter increased to 130 just before surgery. Abdominal x-rays showed an ileus. The white blood cell count was 12,400 per cu. mm. with 85 per cent neutrophils and 14 per cent lymphocytes. The red blood cell count, hemoglobin and hematocrit were normal. The coagulation time was four minutes, thirty-five seconds despite the administration of heparin. With a preoperative diagnosis of acute mesenteric thrombosis, laparotomy was performed approximately eighteen hours after the onset of abdominal symptoms. The skin incision revealed numerous subcutaneous and intramuscular recent venous thrombi. The peritoneal cavity contained a moderate amount of serosanguineous fluid. The large intestine with its mesentery was gangrenous from the mid-transverse colon to the distal signoid colon. Thrombi could be palpated and seen within the inferior mesenteric vein. Resection of the gangrenous segment of colon was accomplished with the establishment of a transverse end colostomy in the right upper quadrant and closure of the rectosigmoid junction in the pelvis. An accidental splenic pedicle laceration necessitated splenectomy. Two days later the patient was again given heparin. On November 17 coumadin® was started and heparin discontinued after an adequate prothrombin time was reached. The patient also received appropriate antibiotics. He had a temperature of 99 to 102°F. for several weeks. Subsequent x-rays revealed an increased left lower lobe infiltration and an elevation of the left diaphragm. In addition, there was subcostal tenderness on the left. It was the clinical impression that the patient had a left subphrenic abscess and this was evacuated on December 11 through an incision in the bed of the resected twelfth rib. Coumadin and antibiotics were continued. One day postoperatively he hemorrhaged from the subphrenic incision and went into profound shock. Coumadin was discontinued and vitamin K_1 was given. Via the femoral artery, 1,500 cc. of blood was administered immediately followed by another 1,500 cc. of blood in the next

forty-eight hours. The patient slowly regained much of his weight and on April 8, 1957, the transverse colon was anastomosed to the rectosigmoid stump. The postoperative course was uneventful, and a barium enema and sigmoidoscopy showed an adequate anastomotic stoma. He has had no further anticoagulants. Slight edema of the left leg on long standing is well controlled by the use of an ace bandage. His chest x-ray is normal. The patient has returned to his occupation as a truck driver and construction foreman.

The diagnosis was mesenteric venous thrombosis and infarction of the large bowel.

CASE II. A. R. G., a fifty-seven year old white man, was admitted on September 14, 1957, with a two-day history of slight abdominal distention, dull aching pain in the epigastrium of increasing severity, persistent vomiting of a brown fluid and a diagnosis by his physician of a bleeding ulcer. He had several watery bowel movements two days prior to admission, but none on the day immediately preceding admission.

For two to three months prior to admission the patient had been passing watery stools almost daily, and he suspected a slight weight loss although his appetite was good. Occasionally he had bouts of mild abdominal pain, usually of short duration. There was no history of either excessive alcohol intake or of intestinal parasitic disease.

On physical examination the temperature, pulse, respiration and blood pressure were normal. The tongue was dry and slightly coated. Occasional extrasystoles were heard. The abdomen was distended and there was mild tenderness with rebound, particularly in the lower half of the abdomen. The umbilicus was slightly protuberant and tender. There were no palpable masses. Bowel sounds were hypoactive and shifting dullness was elicited. Rectal examination was negative for abnormalities.

The initial diagnosis was peptic ulcer, and antacids and sedatives were given. He continued to vomit light yellow and brown material, and passed approximately 200 cc. of bright red blood per rectum. On the following day the abdominal pain shifted from the upper to the lower abdomen, and the patient became progressively worse. The temperature was 99.4°F. and the pulse 84. The white blood cell count was 23,150 per cu. mm. with 94 per cent neutrophils. The hemoglobin was 16.2 gm. per cent, the hematocrit 50 per cent and the red blood cell count was 5,880,000 per cu. mm. X-ray of the abdomen showed marked distention of the small intestine with a stepladder pattern but no free intraperitoneal air. A barium enema showed incomplete filling of the cecum and intussusception was considered. On September 15 the abdomen was explored. A moderate amount of pink-amber intraperitoneal fluid was noted, and the small intestine was markedly dilated. A few fibrinous adhesions were freed after which a 1¼ foot segment of gangrenous jejunum located 2½ feet distal to the ligament of Treitz was encountered. The mesentery of the segment was markedly edematous, and the veins were occluded with thrombi. The gangrenous bowel was resected and end-to-end anastomosis performed.

Postoperatively the patient did well and was soon eating and out of bed. However, on the tenth day he vomited several times, again complained of abdominal pain and became distended; lower abdominal tenderness and rebound developed. The abnormal x-ray showed early intestinal obstruction. The white blood cell count was 30,150 per cu. mm. with 94 per cent neutrophils; hematocrit was 50 per cent. Laparotomy was performed. The peritoneal cavity again contained a moderate amount of serosanguineous fluid. The small intestine was distended and there was a gangrenous 2½ foot segment of small intestine located approximately 1 foot distal to the previous anastomosis. The mesentery was similar to that of the first operation. This gangrenous segment was resected and a second end-to-end anastomosis performed. Postoperatively the patient's course was stormy. He was given 50 mg. of aqueous heparin subcutaneously every six hours on October 4, 1957. Anticoagulants were continued until October 29 when the patient had several serosanguineous bowel movements. Heparin was immediately discontinued and protamine and blood transfusions were given. Within twenty-four hours bleeding ceased. His convalescence after that was uneventful.

COMMENTS

While the etiology of the mesenteric venous thrombosis in the second case can probably be explained on the basis of an associated enterocolitis which had been responsible for the patient's diarrhea for several months prior to his present illness, no definite etiology can be stated for the first case in which none of the laboratory studies were abnormal. At one time the diagnosis of thromboangiitis obliterans was considered because of the migratory phlebitis which was evident. It was also thought that the known history of malaria and typhus was significant, since these diseases may produce an obliterative arteritis. However, there was insufficient microscopic evidence of arterial inflammatory disease which should be present in each of these diseases. This patient showed no portal vein thrombosis, and the removed spleen was not congested. The association of venous thrombosis in the viscera with thrombosis of

peripheral veins has been discussed by Cruickshank [1] and referred to as "primary idiopathic venous thrombosis."

It is of some significance that the patient in Case I required large doses of heparin preoperatively. In retrospect, he was apparently refractory to heparin. Later, he hemorrhaged almost to exsanguination because of the continuance of another anticoagulant, coumadin. This was true despite the fact that splenectomy was added to the bowel resection, and if anything, should have increased the need for anticoagulants.

In both cases attention is called to the insidious onset of symptoms. Mesenteric thrombosis was thought of in the first case because of the patient's known thrombotic history. The second case presented itself as an abdominal emergency in a patient who had been ill for several days.

Involvement of the inferior mesenteric vein is extremely rare. This vein drains the distal transverse colon and the left colon to the rectosigmoid area where the middle hemorrhoid veins, which enter the caval system, give collateral drainage.

The importance of anticoagulants is illustrated. It is quite probable that had anticoagulants been given following the first resection in Case II, a second thrombotic episode might not have occurred. In this instance the patient was confronted with the same etiology that had produced the first thrombotic episode, plus the added burden of recent surgical trauma.

The risk of anticoagulant therapy is demonstrated. In Case I severe bleeding followed incision and drainage of a subphrenic abscess in a patient receiving coumadin. In Case II bleeding occurred on the twenty-fifth day of heparin therapy although the coagulation time was within accepted therapeutic range.

SUMMARY

Two cases of mesenteric venous occlusion, one involving the inferior mesenteric vein and the other involving the superior mesenteric vein, are presented and discussed. Both patients survived surgery.

Acknowledgment: I wish to thank Dr. E. J. Carry, Chief, Surgical Service, Veterans Administration Center, Whipple, Arizona, who was the operating surgeon on Case II, for permission to include this case in the report.

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Traumatic Intramural Hematoma of the Duodenum

GEORGE H. PESTER, M.D. AND PATRICK PEARTREE, M.D., *Council Bluffs, Iowa*

From the Jennie Edmundson Memorial Hospital, Council Bluffs, Iowa.

EXTRAVASATION of blood into the submucosal or subserosal layers may produce partial or complete obstruction of the duodenum. In 1933 Oppenheimer [1] was the first to report two cases; one a complication of extensive neoplastic invasion of the duodenum, and the other from a ruptured aneurysm. In 1952 Dey [2] reported one case with no history of injury or known blood dyscrasia.

The first case of intramural hematoma of the duodenum caused by injury was reported by Stirk [3] in 1953. Additional cases caused by injury include one by Magladry and Mathewson [4] in 1954, four by Felson and Levin [5] in 1954, one by Snider [6] in 1956, and one by Watanabe and Inouye [7] in 1956.

On study of the upper gastrointestinal tract with barium, Felson and Levin [5] noted that the obstructed area of the duodenum had a characteristic "coiled spring" appearance. This finding was present in their four cases and they considered it to be an important diagnostic roentgen sign. Snider reported a similar finding in his patient.

Since this condition has been recognized only recently as a distinct entity, we believed that our case should be reported and the treatment discussed.

CASE REPORT

The patient, a ten year old white boy, was admitted to the Jennie Edmundson Hospital on March 6, 1957. On March 3rd, while playing basketball, he fell on some wire and a portion of a cement block. He complained immediately of sharp pain in the abdomen but ten minutes later returned to play basketball. Three hours after the injury he refused to eat his evening meal and four hours after the injury he vomited and continued to vomit to the time of hospital admission. He also complained of periodic paroxysmal abdominal pain. The parents had not noted any bright blood or old blood in the vomitus. There had been no bowel movement for two days.

Physical examination revealed no abnormalities except for marked dehydration and the abdominal findings. There were no marks of injury. The abdomen was moderately distended and there was tenderness in the epigastrium.

Flat and upright films of the abdomen were essentially normal. The patient was given a small amount of barium by mouth and the stomach was noted to be markedly dilated and to extend into the pelvis. (Fig. 1.) The stomach contained a large amount of fluid. No barium could be expressed beyond the duodenal bulb.

A Levin tube was inserted into the stomach and the patient was given parenteral fluids to correct the dehydration. Nasogastric suction was continued overnight. The gastric drainage contained "coffee ground" material and bile. After the stomach was emptied, the patient stated that he was comfortable.

Physical examination of the abdomen on the following day was entirely normal. The abdomen was scaphoid; there were no areas of tenderness and no masses were palpable.

On March 7th, after twenty-four hours of gastric suction, upper gastrointestinal examination with barium revealed almost complete obstruction of the second portion of the duodenum. The esophagus, stomach and duodenal bulb were normal. Definite narrowing was noted, with anterior displacement of the second portion of the duodenum by an extrinsic mass. At the four-hour examination there was marked retention of barium in the stomach, and only a small portion of the barium had passed into the lower small bowel. A diagnosis of intramural hematoma of the second portion of the duodenum was made. The area of obstruction of the duodenum had the typical "coiled spring" appearance reported by Felson and Levin. (Fig. 2.)

On March 8th, with the patient under general anesthesia, the abdomen was opened through a high right transverse incision. There was no free

FIG. 1. Upper gastrointestinal series on the day of admission. The stomach is markedly dilated and filled with fluid; no barium passed through the duodenum.

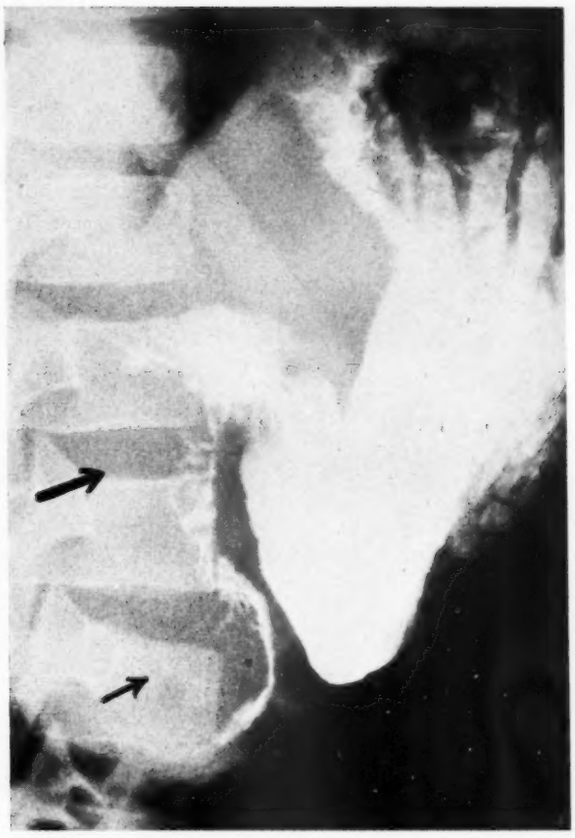

FIG. 2. Examination twenty-four hours later after nasogastric suction. The "coiled spring" effect of the proximal duodenum was more obvious at fluoroscopy and on spot films than on this reproduction. Note anterior displacement and narrowing of distal descending arm of the duodenum, the site of the hematoma.

fluid or blood within the peritoneal cavity. The abdominal viscera were essentially normal with the exception of the duodenum. There was an ovoid mass approximately 6 by 4 by 4 cm. involving the lateroposterior wall of the second portion of the duodenum. The mass had the appearance of a hematoma. It was incised with a short longitudinal incision placed laterally, and approximately 60 cc. of old dark blood and a few small clots were evacuated from the submucosal area. This completely decompressed the mass. Incidental appendectomy was performed. The abdomen was closed with a Penrose drain inserted down to the foramen of Winslow and brought through a stab wound placed below the abdominal incision.

The postoperative period was uneventful. The patient was started on a progressive diet. The drain and the sutures were removed on the fifth postoperative day; there was no drainage from the stab wound. Upper gastrointestinal studies made on the fifth postoperative day were essentially normal. (Fig. 3.) The patient was dismissed the same day. Upper gastrointestinal studies repeated four weeks later were also normal. At that time the patient was feeling well and was eating a usual diet without difficulty.

Blood studies, including platelet count, bleeding time, coagulation time and clot retraction time, were normal.

COMMENTS

X-ray studies of the abdomen in this particular case of trauma were diagnostic. After ruling out the possibility of a ruptured viscus by clinical examination and by flat and upright roentgenograms of the abdomen, the patient was given a small amount of barium by mouth. This examination revealed complete obstruction of the outlet of the stomach. After prolonged aspiration of the stomach, barium studies on the following day revealed the typical "coiled spring" appearance of an intramural hematoma in the descending duodenum.

Incomplete obstruction of the duodenum from an intramural hematoma may be treated successfully by watchful waiting. One case reported by Felson and Levin [5] was so treated.

FIG. 3. Re-examination five days after surgical evacuation of the intramural hematoma.

Snider [6] explored the abdomen of his patient but did not evacuate the hematoma because of incomplete obstruction. However, he was of the opinion that drainage of the hematoma would provide less morbidity.

The remainder of the reported cases were treated by surgical evacuation of the hematoma, with or without gastroenterostomy. If the obstruction is relieved by evacuation of the hematoma, a more extensive procedure is unnecessary. If doubt exists that the obstruction cannot be relieved, a short-circuiting gastroenterostomy would be indicated.

Simple drainage of the hematoma in this case led to a rapid and complete recovery.

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Internal Fistula of the Nasopharynx Thought to Be of Developmental Origin

LOUIS G. LUDINGTON, M.D. AND MARIO J. ACQUARELLI, M.D., *Los Angeles, California*

From the Head and Neck Section of the General Surgical Service, Wadsworth General Hospital, Veterans Administration Center, Los Angeles, California.

THERE have been several reports in the English literature during the last few years of nasopharyngeal cysts and sinuses which were reputedly of embryological origin. Taylor and Burwell [6] culled from the literature five cases of unilateral nasopharyngeal cysts. To these they added three additional cases of their own, two of bilateral cysts and one of a unilateral cyst, all located in the nasopharynx. The cysts were all apparently attached to the lateral wall of the nasopharynx below and posterior to the eustachian orifice and cushion. The authors gave rather convincing proof that the cysts were of developmental origin. In 1955 Wilson [9] reported a case of bilateral symmetrical sinuses opening into the lateral walls of the nasopharynx below and posterior to the eustachian cushion behind the palate. The injected tracts were demonstrated by x-ray film to pass upward and outward for a distance of about 1 inch parallel with the direction of the eustachian tube. Table 1 summarizes these cases as to age, sex of patient, side involved and type of epithelial lining of the cyst or sinus. To this group of nine cases we wish to add a tenth which we believe is of a similar developmental origin.

TABLE 1
REPORTED DEVELOPMENTAL CYSTS AND SINUSES OF THE NASOPHARYNX

Reference	Age (yr.) and Sex of Patient	Epithelial Lining	Cyst or Sinus, and Side Affected
Magnotti, 1927 [4]	8, F	Ciliated columnar, pseudostratified	Cyst; side not stated
Giussani, 1928 [2]	25, M	Simple or stratified columnar	Cyst; left
Swinburne, 1939 [5]	59, F	Ciliated columnar	Cyst; left
Hoogland, 1951 [3]	69, M	No histology	Cyst; right
Taylor and Burwell, 1954 [6]:			
Case I	53, M	Ciliated columnar, pseudostratified	.....
Case II	49, M	Stratified squamous	.....
Case III	54, M	Pseudostratified ciliated columnar and stratified columnar	.....
Wilson, 1955 [9]	?	Ciliated columnar	Bilateral sinuses

CASE REPORT

A sixty-two year old white male chicken farmer was admitted to the Wadsworth General Hospital, Veterans Administration Center, on October 10, 1957. He had a sixteen-year history of rheumatoid arthritis and a septic arthritis of his left knee of recent origin, for which he was admitted to the orthopedic ward. Five days after admission a large, tender nodule was noted in the right side of the neck behind the sternocleidomastoid muscle and 2½ inches below the mastoid process. The mass was about 2 to 3 cm. in diameter and tender. On October 31st the mass was noted to be fluctuant and so was excised and drained. Cultures grew a hemolytic staphylococcus aureus, coagulase positive. Smears for acid-fast and fungus organisms were negative. Careful examination of the ears, nose, pharynx and larynx revealed no abnormal findings. The skin of the head and neck was clear. The patient did give a history of having had a sore throat for several days in January and again in April, 1957, but there was no history of tuberculosis in the patient, his family or friends. Roentgenogram of the chest showed no abnormalities, and the roentgenograms of the cervical spine revealed degenerative spondylitis but no inflammatory or destructive changes. The rest of the examination and laboratory reports were non-contributory.

Because the wound continued to drain, the orthopedic physician began daily irrigations with a .5 per cent solution of neomycin® sulfate. At the

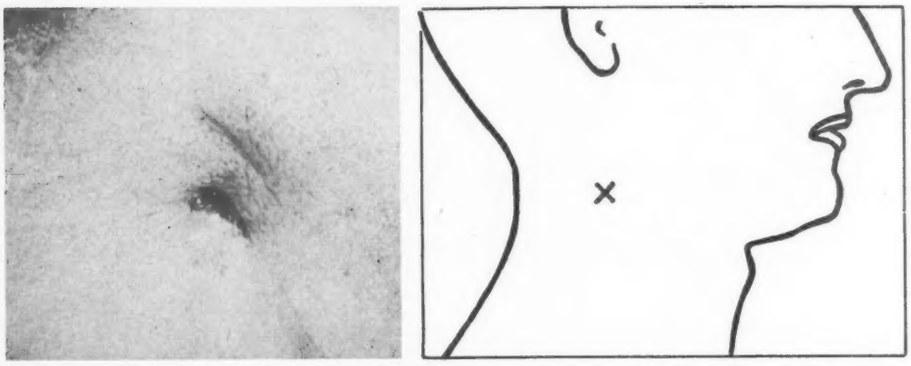

FIG. 1. Demonstrates the external orifice of the cervicocutaneous-nasopharyngeal fistula. Notice that it lies behind the sternocleidomastoid muscle.

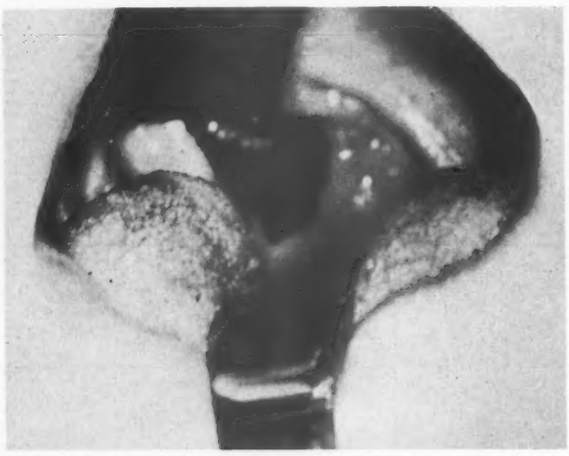

FIG. 2. The tongue is depressed and the soft palate elevated so that dye can be seen emerging from the internal orifice of the nasopharyngeal fistula just behind the soft palate.

time of the second irrigation on December 4th the patient complained that the solution was running into his throat. At this point he was transferred to the Head and Neck Service.

To demonstrate the fistula and locate its internal orifice, methylene blue was injected. The internal orifice was found to enter the nasopharynx at about the midline of the posterior wall just behind the soft palate. The orifice was about 2 mm. in diameter without surrounding induration or erythema, making it difficult to visualize. Figures 1 and 2 demonstrate the external and internal orifices of the fistula after the injection of dye. X-ray films of the tract were taken after injection of radiopaque solution. A lateral x-ray view of the injected tract can be seen in Figure 3. The artist's sketch at the right indicates more clearly the path of the radiopaque dye on the roentgenogram. On December 16th the patient was taken to surgery and an attempt made to dissect the tract. After excising a granulating cavity inferior to the skin orifice, difficulty was encountered in following the tract despite the injection of methylene blue prior to surgery. Pathological examination of this surgical specimen demonstrated only chronically inflamed granulation tissue with no epithelial-lined tract. On December 27th the internal portion of the tract was excised through a transoral approach and could be followed for approximately 2 cm., passing to the right, upward and backward in proximity to the right eustachian tube orifice. Pathological examination by serial sections of this specimen revealed a tract lined with stratified squamous epithelium with subepithelial lymphoid tissue. In areas the epithelium was eroded by the inflammatory process as shown in Figure 4.

Comment. Our opinion is that this patient had a developmental nasopharyngeal sinus, probably a vestigial of the dorsal end of the second branchial pouch as indicated by the location of the internal orifice. Temporary blockage led to inflammation and abscess formation of the external end of the tract which was in a subcutaneous position. The tract in this patient entered the nasopharynx more posteriorly than that in Wilson's case [9], but at the same level in the nasopharynx. The tract also seemed to be more extensive in penetration of the structures of the neck, apparently ending in a subcutaneous position. Surgical incision and drainage of the abscess converted the tract into a complete fistula.

EMBRYOLOGY

No attempt will be made to review in detail the embryological and anatomical development of the branchial apparatus. For this information the reader is referred to the excellent review by Wilson published in 1955 [9]. Pertinent to this article though, we would like to recall some aspects of branchial development. The four

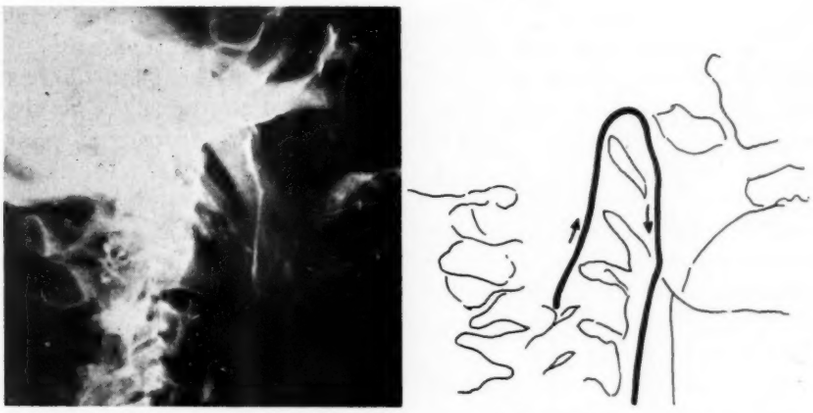

FIG. 3. Lateral x-ray film demonstrating tract of fistula. Radiopaque solution was injected at the external orifice of the fistula, indicated by arrow. From here solution traveled upward to enter nasopharynx. From there the radiopaque material can be seen running down, coating the posterior wall of the oro- and laryngopharynx and entering the esophagus. The artist's sketch at right indicates more clearly the path of the injected dye.

prominent visceral ridges or arches appear in the 3 mm. embryo slightly before the third week with their corresponding ectodermal clefts and endodermal pouches cauded to each arch. By the seventh week the latter have completely disappeared. Interference during this important period leads to developmental errors in the branchial apparatus. Each of the arches has its own musculature, vessels and nerves. Cysts, sinuses or fistulas developing from the remnants of the clefts and pouches can be charted accurately by their relation to these structures. For instance, the posterior digastric muscle, muscles of expression, the facial nerve and the internal maxillary artery come from the mesoderm of the second arch. The stylopharyngeus muscle, glossopharyngeal nerve, and common and internal carotid arteries come from the third arch, etc. The hypoglossal nerve conversely is derived from the mesoderm around the cervical spine and grows forward caudad to the branchial apparatus, turning upward lateral to the pharynx to penetrate the pharyngeal wall between the anterior ends of the second arch to reach the tongue. This course is superficial and lateral to all vessels and nerves. Ectodermal structures would be superficial to these nerves, but any vestigial structure arising from the pouches would be deep to the nerves. These carefully worked out anatomic relations pinpoint the part of the branchial apparatus involved by a fistula, sinus or cyst.

FIG. 4. Photomicrograph of epithelial lining of fistulous tract.

Turning our attention to the branchial pouches, the second is noted to be the largest. It is wide from its dorsal to its ventral end, each end producing a deeper pouch. As development occurs, the palate cuts across, dividing it into a dorsal nasopharyngeal pouch and a ventral pharyngeal pouch. The dorsal pouch of the second is in close proximity to the first pouch,

and together they form the eustachian tube and middle ear. The ventral branchial endodermal pouch of the second extends to meet the second ectodermal cleft from which it becomes separated by only a thin membrane. Should development become arrested here, the thin membrane would be broken down and a complete fistula remain. This is the etiology of the lateral developmental fistulas of the neck. Only rarely does this happen, however, for generally the mesoderm of the third arch encroaches on and obliterates the ventral pouch. The tonsil develops at the pharyngeal end of the second pouch.

The majority of all lateral cysts and sinuses, and all fistulas, are of second branchial cleft and ventral pouch origin. The tract of the common fistula has its external orifice in the skin somewhere along the anterior border of the sternocleidomastoid muscle, usually about 1½ to 3 inches from the sternoclavicular joint. It passes inward through the platysma muscle and ascends superficially to the lower part of the sternothyroid muscle and anterior belly of the omohyoid muscle, coming to lie on the internal jugular vein. On reaching the lower border of the posterior belly of the digastric muscle, it passes deep to this muscle and the stylohyoid muscle, crosses over the hypoglossal nerve, then passes between the internal and external carotid arteries to be on the lateral wall of the pharynx, entering the pharynx between the superior and middle constrictor muscles to have its internal orifice on the posterior tonsillar pillar or adjoining margin of the soft palate. Skeletal muscle from the platysma surrounds the external portion of the tract, and from the palatopharyngeus, the internal portion of the tract. The swallowing act contracts these muscles and dimples the external orifice.

In rare cases when the external opening is behind the ear, the tract penetrates between the mastoid process and the insertion of the sternocleidomastoid muscle. Passing then between the posterior border of the lower pole of the parotid gland and the facial nerve, the tract turns downward behind the base of the styloid process, to run first above and then beneath the posterior digastric and stylohyoid muscles. The remainder of the tract continues as previously described.

Interference with development of the first branchial pouch results in malformation of the eustachian tube and middle ear. A similar condition effecting the second would lead to a complete fistula as previously mentioned, or an internal or external sinus or cyst. If the ventral portion of the pouch is involved, the internal orifice would enter the pharynx along the posterior pillar of the tonsil, the most common type. Rarely the dorsal pouch of the second is involved; then the site is in the nasopharynx in the region of the eustachian tube behind the palate as reported in the early paragraphs of this article.

In 1865 Virchow [7] reported a dissection of a stillborn fetus of 42 cm. with a right-sided branchial fistula, entering the nasopharynx just behind the soft palate. The auditory apparatus on the right was deformed, the external ear demonstrating an incomplete ring of cartilages surrounding a small fissure which represented the unformed auditory canal. A eustachian tube was present deep to this, but it failed to enter the nasopharynx. The fistulous tract started in the skin behind the ear lobe posterior to the sternocleidomastoid muscle, then passed between elements of the second and third branchial arches. These relations tag the tract as of second branchial cleft and pouch origin rather than first cleft origin as Virchow concluded. Its internal orifice opened at the site of the second dorsal pouch. This case represented arrested development of the first branchial cleft and pouch as evidenced by the deformed eustachian tube, middle ear and auricle, and also interference with development of the second cleft and dorsal pouch as demonstrated by the fistula.

Usually sinuses and cysts of branchial pouch origin are lined with ciliated columnar or pseudostratified columnar epithelium while those of ectodermal origin are of stratified squamous epithelium. Branchial fistulas usually have stratified squamous epithelium lining their outer part, and ciliated columnar epithelium their inner part. This does not always hold true, however. One of Taylor and Burwell's [6] patients had a cyst lying in the nasopharyngeal wall lined with stratified squamous epithelium. Fistulous tracts have been reported completely lined with squamous epithelium. Subepithelial lymphoid tissue is another characteristic feature of these branchial cysts, sinuses and fistulas. This was present in the case reported.

No mention has been made of Wenglowski's [8] theory of thymic duct persistence to explain

these lateral cervical cysts, sinuses and fistulas. The thymic duct is derived from the third pouch, so a fistula or sinus of such origin would have to run upward beneath the infrahyoid muscles, behind the lateral lobe of the thyroid gland, then penetrate the thyrohyoid membrane to open into the piriform fossa. No such fistulas have been described to our knowledge, although some cysts and sinuses have been reported to enter the pharynx in this area and may be of vestigial thymic duct origin. Certainly it could not explain the cases mentioned in this paper.

SUMMARY

A case is reported of a sixty-two year old white man in whom an abscess developed in the right posterior triangle of the neck which proved to be connected to a sinus entering the nasopharynx behind the soft palate. This was converted to a fistula when the abscess was drained externally.

Nine reports of nasopharyngeal cysts and sinuses collected from the literature and thought to be of developmental origin are cited. A few aspects of embryological development are reviewed. We believe that Taylor, Burwell and Wilson are correct in attributing these nasopharyngeal cysts and sinuses to vestigial remains of the dorsal end of the second branchial pouch.

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Lymphangiosarcoma in the Postmastectomy Lymphedematous Arm

WILLIAM P. DOREMUS, M.D. AND GASPARE A. SALVIA, M.D., *New York, New York*

From the Surgical Service, Lenox Hill Hospital, New York, New York.

IN 1948 Stewart and Treves [*14*] first reported six cases of lymphangiosarcoma developing in the lymphedematous arm following radical mastectomy. Twenty cases of this symptom complex have been reported including the case reported herein (Table 1), all showing the characteristic pattern of a predominantly fatal tumor. A common entity, in all instances, has been the persistent lymphedema of the arm for a duration of five to twenty-four years before the primary site appeared in the skin.

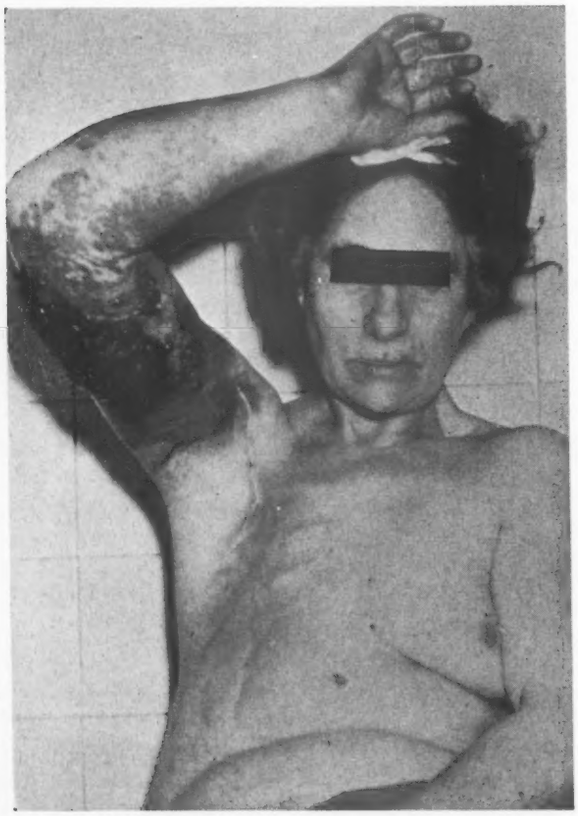

FIG. 1. Patient with lymphangiosarcoma, one day before interscapulothoracic amputation.

The early benign appearance of the skin changes in the postmastectomy edematous arm is misleading. In most cases the lesion was observed for many months before the presence of malignancy was suspected. The lesion is first noticed as a purplish-red subdermal macular or polypoid area, often described clinically as a hemangioma or ecchymosis secondary to trauma. It may develop anywhere in the skin of the edematous extremity, usually as a solitary tumor followed by multiple satellite areas that become confluent. The advanced lesion (Fig. 1) progresses into a papillomatous, ulcerated mass and discharges a serosanguineous exudate. Metastases are blood-borne, almost without exception, to the lung. Local recurrence following surgery or radiation therapy has occurred in almost every case. Radical surgery and radiation were used in the treatment of the case herein described.

The average age of the patients in the twenty collected cases was approximately sixty-three years with the youngest being forty-seven and the eldest seventy-seven years of age. The interim between radical mastectomy and the appearance of lymphangiosarcoma averaged ten and a half years. None of these patients were reported as having any recurrent mammary cancer. Radiation therapy was administered to twelve of the twenty patients following radical mastectomy. Four of the patients did not receive roentgen therapy and there is no information regarding this point on three cases. Etiologically there is no apparent correlation between the mammary tumor, postmastectomy radiation, or degree of lymphedema. Martorell [*8*] reported one case of lymphangiosarcoma developing in the lymphedematous leg following a compound fracture and it is no longer the

TABLE I

SUMMARY OF TWENTY CASES OF LYMPHANGIOSARCOMA OF THE LYMPHEDEMATOUS ARM AFTER RADICAL MASTECTOMY

Author	Age of Patient	Years Post-mastectomy	Tumor of the Breast	Nodes Involved	X-ray Treatment	Onset and Duration of Lymphedema	Treatment	Follow-up
Stewart and Treves, 1948 [14]	58	8	Adenocarcinoma, grade III	?	Yes	Immediate, 8 yr.	Interscapulo-thoracic amputation	Died
Stewart and Treves, 1948 [14]	68	8	Plexiform carcinoma	No	Yes	Immediate, 8 yr.	Wide excision	No data
Stewart and Treves, 1948 [14]	69	10	Infiltrating duct cell carcinoma	No	No	Immediate, 10 yr.	Interscapulo-thoracic amputation	Died 20 mo., metastasis
Stewart and Treves, 1948 [14]	47	10	Scirrhous carcinoma	No	Yes	1 yr., 9 yr.	Interscapulo-thoracic amputation	Died 5 mo., lung metastasis
Stewart and Treves, 1948 [14]	65	24	Malignant neoplasm	?	No	Immediate, 24 yr.	Forequarter amputation	Died 1 mo., metastasis
Stewart and Treves, 1948 [14]	64	6	Papillary adenocystoma, benign	No	Yes	Immediate, 6 yr.	X-ray	Died 3 mo., pulmonary metastasis
Ferraro, 1950 [2]	66	9	Duct cell carcinoma	No	Yes	Immediate, 9 yr.	No specific treatment	Died 5 mo., metastasis
McCarthy and Pack, 1950 [6]	67	10	Carcinoma	?	?	Immediate, 10 yr.	Interscapulo-thoracic amputation	Died 3 yr., 5 mo., lung metastasis
Cruse, Fischer and Usher, 1951 [1]	65	12	Carcinoma	Yes	Yes	Immediate, 12 yr.	Disarticulation amputation	Died 6 mo., metastasis
Froio and Kirkland, 1952 [3]	54	11	Carcinoma	Yes	Yes	10th yr.	Scapulohumeral amputation	Died 9 mo., metastasis
Jessner, Zak and Rein, 1952 [5]	54	7	Carcinoma	Yes	Yes	Immediate, 7 yr.	Partial amputation	Died 4 mo., lung metastasis
Hilfinger and Eberle, 1953 [4]	52	10	Carcinoma	No	Yes	First yr., 10 yr.	Interscapulo-thoracic amputation	Died 5 mo., lung metastasis
Hilfinger and Eberle, 1953 [4]	63	16	Carcinoma	Yes	Yes	Fifth yr., 11 yr.	Palliative X-ray	Died 4 mo., lung metastasis
Rawson and Frank, 1953, [11]	70	14	Carcinoma	?	?	Immediate, 14 yr.	X-ray (patient refused surgery)	Died 4 yr., metastasis
Vos, [15]	55	14	Carcinoma	?	?	Immediate, 14 yr.	X-ray and wide excision	Died 6 mo., metastasis
Southwick and Slaughter [13]	49	8	Adenocarcinoma	Yes	No	Immediate, 8 yr.	X-ray (patient refused surgery)	Alive 9 yr. later
Marshall, 1955 [7]	71	5	Adenocarcinoma	Yes	No	Immediate, 5 yr.	Interscapulo-thoracic amputation	Died 11 mo., lung metastasis
Nelson and Morfit [10]	77	9	Carcinoma	Yes	Yes	16 mo., 8 yr.	X-ray	Alive 1 yr. (has metastases)
Nelson and Morfit [10]	71	9	Carcinoma	?	?	Immediate, 9 yr.	Excision and graft	Died 1 yr., local recurrence lung metastasis
Doremus and Salvia	72	11	Carcinoma	Yes	Yes	Immediate, 11 yr.	Interscapulo-thoracic amputation	Died 11 mo., lung metastasis

belief that this is a tumor only of the edematous arm following mastectomy.

Treatment of the lymphangiosarcoma varied and no one procedure in any group of cases has yet proved to be uniformly effective. Fourteen of the twenty patients were treated surgically; nine had interscapulothoracic amputations, two had partial amputations and three had wide excisions. All died on the average of 8.4 months postoperatively. Of the five patients treated with radiation alone, two are alive. The patient of Southwick and Slaughter is alive nine years later (at the time of this writing) and free of disease [13]. The patient of Nelson and Morfit is alive one year later (also at the time that this is written) but has evidence of metastasis [10].

CASE REPORT

This seventy-three year old woman had a right radical mastectomy performed in May 1943 for carcinoma of the breast with microscopically involved axillary lymph nodes. Postoperatively, she received a total of 1,800 r to each of five portals.

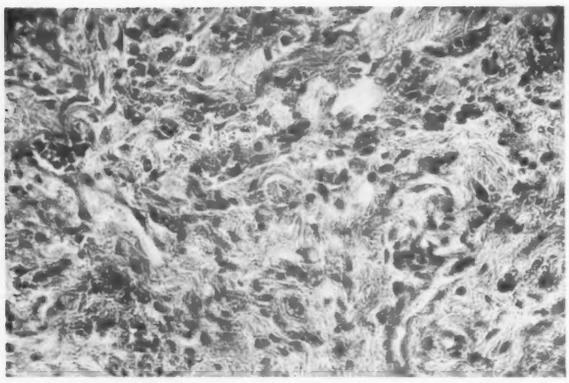

FIG. 2. Infiltration of subcutaneous tissue by lymphangiosarcoma.

Five weeks after the operation and radiation therapy, the patient noticed lymphedema of the ipsilateral arm.

For eleven years this patient was seen regularly in the tumor follow-up clinic of the Lenox Hill Hospital and she was found to be free of any local or distant metastasis. On the visit of March 9, 1954, the lymphedema was moderate. She complained of a "bruise mark" on the medial aspect of the lymphedematous arm. She denied any recent trauma but stated that this discoloration had been present for only two weeks.

The bruise mark was described by the physician as follows: ". . . an ecchymotic zone on the medial aspect of the arm with an area of yellowish peripheral pigmentation. Central to this area is a reddish-purple ecchymosis measuring 6 cm. × 5 cm. which has local heat and is slightly tender. In the same area there is a 3 mm. × 3 mm. hemangioma-like raised lesion." These findings were believed to be secondary to trauma and the patient was treated with moist compresses and elevation of the arm.

The ecchymosis appeared to diminish considerably after three weeks. The patient was not seen again until seven months later in October 1954. At this time the hemangiomatous lesion was larger and was draining sanguineous fluid.

The patient was admitted to the hospital on December 12, 1954 for biopsy of the lesion and for treatment. The microscopic examination of multiple biopsies was first reported as "no diagnosis." The x-ray film of the pulmonary field was negative. The patient was discharged at her request. She returned in January, 1955 and a positive biopsy was obtained with a diagnosis of lymphangiosarcoma. (Fig. 2.)

There was a delay of ten months between the patient's first visit for this condition and the onset of definitive treatment. On January 11, 1955, a right interscapulothoracic amputation was performed. The patient made a rapid recovery and was discharged eleven days postoperatively.

She was followed up in the surgical clinic and remained well until six months later when a yellowish pigmentation was observed on the chest wall. This pigmentation resembled an ecchymosis similar to the primary lesion and developed the characteristic hemangiomatous nodules. A film of the chest revealed underlying pulmonary metastasis. The chest wall recurrence was treated with radiation (2,200 roentgen units) over a span of eight days. This therapy effected marked diminution in the chest wall recurrence but had no effect on the pulmonary metastasis. The patient died on November 4, 1955 of lung metastases, twenty months after the appearance of the lymphangiosarcoma and eleven months after interscapulothoracic amputation.

COMMENTS

The patient whose case is described herein was without lung metastasis when treated by interscapulothoracic amputation ten months after the lesion on the arm first appeared. The late diagnosis in this case had some bearing on the treatment instituted, in that the local lesion was so extensive that radical amputation was the only recourse. The recurrence on the chest wall postoperatively was highly sensitive to radiation. Even though radiation effected an almost complete regression of recurrent tumor, the response was only temporary. In such an extensive lesion, perhaps preoperative radiation therapy might be considered. As yet, no case has been reported in which preoperative radiation was given to the primary lesion.

CONCLUSION

Lymphangiosarcoma is a rare malignant disease that may ensue in the chronically edematous extremity following radical mastectomy. A case of this disease is reported and nineteen cases from the literature are reviewed. Interscapulothoracic amputation and radiation therapy were employed in the treatment of our patient.

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"Francois Magendie was born in Bordeaux, France, in 1783. . . . He was the pioneer of experimental physiology in France. . . . He has been referred to as the modern founder of experimenting pharmacology. In anatomy we refer to Magendie's foramen, the foramen which connects the fourth ventricle with the subarachnoid space. He did not have any use for the usual theories employed in his day, but looked upon medicine as 'a science in the making.' He did not look upon pathology as 'the physiology of the sick man.' In physiology he strove to further his findings by a closer tabulation of already accepted facts. It has been written that he likened himself to a ragpicker who wandered through the land of science collecting whatever he found. His work resulted in the discovery of only isolated facts. He did not attempt to connect them and he arrived at no important generalizations. He was firm in his belief as to the value of experimentation on living animals. There is no doubt that many of his experiments were done without any ultimate object in view and were truly cruel. Because of this he has had the particular aversion of the anti-vivisectionists. Magendie founded the first periodical devoted exclusively to physiology, *The Journal de Physiologie Experimentale*. His greatest contributions to science were his experimental proof of the truth of Bell's law, his investigations with the mechanism of deglutition and vomiting, and the effects of excision or section of the cerebellum. He is also known for his researches of the 'circus movement' obtained by lesion of the optic thalamus. He demonstrated the cause of the blood flow in the veins due to the pumping power of the heart, that osmosis through the vessel walls is due to the chemical difference between the blood and the lymph, and that the absorption of fluids and semi-solids is a function of the blood vessels as well as of the lymphatics. He early noted that arterial blood pressure rises with expiration. Magendie introduced bromine iodine compounds, strychnine, morphine, veratrine, brucine, piperine, and emetine into medical practice. He conducted the first experiment in anaphylaxis or supersensitization of the tissues (1839). He died in 1855 at the age of seventy-three years." (T. S. W., *Am. J. Surg.*, 13: 324, 1931.)

Congenital Atresia of the Sigmoid Colon

GEORGE L. ARMITAGE, M.D. AND HARRY V. ARMITAGE, M.D., *Chester, Pennsylvania*

CONGENITAL intestinal atresia is an uncommon condition, the incidence of which cannot accurately be determined. Estimates of its frequency vary from 1 in 20,000 births (Webb and Wangensteen [*15*]) to 1 in 1,500 births (by Evans [3]). Occlusion may occur at any level but is less frequent in the colon than in the small intestine. The colon is said to be the location of the lesion in 10 to 15 per cent of such obstructions. Failure of re-establishment of bowel lumen between the second to third months of embryologic life is the usually accepted mechanism for the development of the malformation. There is, however, a question concerning the extent and duration of the solid stage of development of the colon. Structurally, the atresia may consist of either an intact diaphragm within the lumen of the bowel or of blind limbs lying in proximity but without actual connection. At times the blind limbs are connected by a fibrous band. In a significant number of cases more than one area of atresia is found to be present and associated anomalies such as malrotation of the intestines and failure of posterior attachment of the mesentery are frequent.

The mortality of congenital intestinal obstruction in larger clinics has been recorded by Wilson et al. [*16*] as varying from 43 to 82 per cent. If treatment is neglected, death usually occurs within the first week of life but on occasion has been reported as late as the ninth or tenth day. Surgical correction must be undertaken at the earliest possible opportunity since the mortality rate increases with the length of time that has elapsed between birth and operation. Infants treated after the fifth day of life are extremely unlikely to recover, for usually by this time necrosis of the obstructed bowel, perforation and peritonitis are complicating factors.

Although the number of successfully treated intestinal atresias is steadily increasing, most of these cases comprise atresia of the small intestine. Chester and Robinson [*1*], in reviewing the literature in 1957, found only eleven successfully treated cases of atresia of the colon and added one more case, for a total of twelve recorded cases. (Table 1.)

CASE REPORT

C. B. (Chester Hospital, No. 15846A), a full term male infant, was born on June 6, 1952. His weight at birth was 6 pounds, 13 ounces. No gross abnormalities were noted at the time of birth but vomiting and progressive abdominal distention began at that time. A small amount of meconium was passed on the first day of life. Examination on the third day of life showed a tightly distended abdomen which was tympanitic to percussion. Visible peristaltic waves were present. Projectile vomiting of bile-stained material occurred during examination. Rectal examination revealed no abnormality. Roentgenograms taken with the baby in the recumbent and inverted positions revealed evidence of organic intestinal obstruction. No gas shadow could be seen in the rectum. A diagnosis was made of congenital obstruction of the colon, and an emergency operation was performed fifty-two hours after birth.

A cannula was placed in the long saphenous vein, through which was given glucose in saline. The infant was anesthetized with open drop ether. The abdomen was entered through a transverse incision in the left lower abdomen, transecting the left rectus muscle. An excessive amount of straw-colored fluid was present in the peritoneal cavity. The entire small intestine and the colon to the mid-sigmoid region of the descending colon were greatly distended. The sigmoid colon terminated in a blind end. The distal sigmoid lay in close proximity but was without actual connection with the proximal blind end. It was extremely diminished in size, being about 4 or 5 mm. in diameter. A needle was inserted into the lumen of the distal colon and water was injected under pressure. The water passed readily into the rectum and through the anus. The two blind ends were brought out onto the abdominal wall and the wound was closed about

TABLE 1

Reference	Age and Sex of Patient	Site	Treatment
Gaub, 1922 [6]	33 hr., M	Sigmoid	Colostomy, still present after 3 yr.
Potts, 1947 [13]	3 days, F	Transverse	Side-to-side anastomosis of transverse colon
Lemmon and Walker, 1948 [12]	1 hr., M	Cecum to splenic flexure	Side-to-side ileocolostomy
Lee and McMillan, 1950 [11]	2½ days, F	Transverse	(1) Closure of perforated cecum; (2) resection of atresia with side-to-side anastomosis 14 hr. later; (3) resection of anastomosis and reanastomosis for partial obstruction 3 mo. later
Jemson, 1951 [9]	3 days, F	Ascending	Side-to-side anastomosis
Gann and Hoffman, 1952 [5]	2½ days, ?	Sigmoid	Side-to-side anastomosis of sigmoid
Gross, 1953 [8]	.....	Cecum or ascending colon*	.....
Wilson, Nelson and Harshbarger, 1954 [16]	36 hr., F	Cecum, transverse	Resection of gangrenous bowel and right colon with end-to-side ileosigmoidostomy
Gerrish, 1955 [7]	1 day, F	Sigmoid	(1) Resection of atresia with end-to-end anastomosis; (2) tube cecostomy
Feggetter, 1955 [4]	3 days, ?	Sigmoid	(1) Transverse colostomy; (2) side-to-side sigmoid anastomosis at 36 days; (3) obstruction of small bowel at 48 days; (4) resection of fistula of small bowel at 55 days; (5) closure of colostomy
Chester and Robinson, 1957 [1]	2 days, F	Transverse	(1) Transverse colostomy; (2) ileodescending colostomy; resection of transverse colon and right colon

* Mentioned by Gross in his textbook, 2 patients.

them. A catheter was placed in the proximal blind end and held in place with a purse string suture. The operation lasted forty-five minutes.

The catheter which had been placed in the distended bowel drained dark, foul-smelling fluid, and a tube placed in the stomach drained almost similar fluid. On the day following the operation the abdominal distention was much decreased. On the third day after surgery oral feedings were started. These were tolerated well from the outset and the baby gradually began to gain weight.

Drainage occurred around the catheter on the second postoperative day and the catheter was removed. The next day semi-solid green fecal material drained through the opening in the bowel. A sinus at the skin level developed in the proximal limb of the colostomy but was of little consequence. The skin sutures were removed twelve days after the operation, at which time the wound was well healed. The baby was discharged from the hospital with a functioning colostomy on the twenty-eighth day of life. It was planned to allow time for further weight gain before closure of the colostomy was attempted.

Two days later the baby was readmitted to the hospital because the mother felt unable to care for the colostomy at home. It was decided after a week's observation to proceed with the second stage of the surgical treatment. Accordingly, the bowel was prepared for surgery with aureomycin® and on July 14th the second operation was performed.

Again a cannula was inserted into an ankle vein for the purpose of administering fluids and blood, and the patient was anesthetized with open drop ether. The two limbs of bowel were freed from the abdominal wall, and an end-to-end anastomosis, using a single layer of interrupted black silk sutures, was made. This was facilitated by incising the small distal limb along its antimesenteric border thus reducing the disparity of proximal and distal lumens at the line of anastomosis. The bowel was returned to the abdomen and the abdominal wall closed. Operating time was one hour.

Oral feedings were started on the second day following the operation and on that evening three watery stools were passed. On the fourth postoperative day purulent drainage from the wound was noted. However, this infection was of slight consequence for by the seventh postoperative day, when the skin sutures were removed, there was minimal evidence of infection and no drainage. The baby was discharged on August 3rd weighing 8 pounds, 10 ounces.

A letter from the mother when the patient was two years of age stated that he was developing normally and was experiencing no bowel difficulty.

COMMENTS

There is little disagreement concerning the majority of essential factors on which survival of these infants depends. They include early diagnosis and treatment, decompression by an inlying gastric tube, intravenous administration of fluids, careful anesthetic technic and control of infection by antibiotics. However, there is no agreement on the best method of correcting the lesion itself. The following methods have been proposed: (1) ileostomy, (2) colostomy, (3) primary side-to-side anastomosis, (4) end-to-side ileocolostomy with right hemicolectomy, (5) ileosigmoidostomy, and (6) end-to-end anastomosis with proximal decompression.

Since the reported survival series is so small, it is impossible to test the value of any one method of treatment. Ileostomy or colostomy has been advised when the patient's condition precludes attempting a more extensive procedure. However, there have been no reported instances of survival of infants with lesions of the right half of the colon treated by this method.

Primary anastomosis is appealing because correction of the malformation is accomplished as one definitive procedure, and primary side-to-side anastomosis is the most widely advocated method of treatment. However, a primary anastomosis, because of proximal bowel distention with its attendant thinning of the wall and because of the small size of the distal segment, is technically difficult to perform and is likely to eventuate in disruption of the anastomosis with its familiar sequelae. If the anastomosis does not leak, it is quite likely to fail to function. Indeed, Wangensteen [*14*] has cited stomal obstruction as the chief cause of death in this condition.

Primary ileocolostomy has been recommended for lesions of the right side of the colon in order to avoid the dangers of ileostomy or cecostomy. Chester and Robinson [*1*] advise right hemicolectomy and end-to-side ileocolostomy. This procedure, of course, exposes the patient to the hazards of primary anastomosis in the presence of distended bowel.

The small size of the colon is inimical to functional re-establishment of bowel continuity and has led Wilson et al. [*16*] to advise ileosigmoidostomy for lesions of the ascending and transverse colon. This would seem to be an unphysiologic operation likely to result in diarrhea. Lane and Franca [*10*] reported a case of congenital microcolon treated by this method in which there was troublesome diarrhea two years later.

Gerrish [*7*] advises primary end-to-end anastomosis with proximal decompression by insertion of a polyethylene tube into the bowel lumen. By substituting the more physiologic end-to-end anastomosis for side-to-side union, later complications are avoided. (These have been listed by Clawson [*2*] as dilatation of the blind pouch, mucosal ulceration and anemia.) While end-to-end anastomosis is theoretically ideal, such a procedure may present formidable technical obstacles because of the unequal size of the proximal and distal segments of bowel.

The operation of ileostomy had fallen into obloquy until Gross [*8*] showed that with careful attention to fluid needs and early closure of the ileostomy, the mortality in obstruction of the small bowel caused by atresia was lower than when primary anastomosis was performed. One reason for this is that the distended bowel has a chance to return to normal size and regain its tonus, thus increasing the possibility of a successful intestinal anastomosis. We believe that the same principle applies to lesions of the large bowel and that primary decompression of the distended bowel should be an integral part of any method of treatment.

SUMMARY

A case of successfully treated congenital atresia of the colon is presented. This represents the thirteenth reported survival of an infant born with this malformation.

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"William Paul Crillon Barton was born in Philadelphia, November 17, 1786. . . . [He] graduated (A.B.) from the College of New Jersey (Princeton) in 1805 and received his M.D. at the University of Pennsylvania in 1808. He entered the navy as assistant surgeon the following year . . . He tired of sea duty after cruises on the *United States* and the *Essex* and requested and was granted duty in Philadelphia where he remained more or less until 1830. Among other accomplishments he abolished the nefarious custom of venereal fees in the American navy. In 1814 he published, 'Treatise Containing a Plan for the Internal Organization and Government of Marine Hospitals, and a Scheme for Systematizing the Medical Department of the Navy.' Later he did a two volume work on 'Medical Botany' and a 'Compendium Florae Philadelphiae.' In 1815 he was made Professor of Botany at the University of Pennsylvania. In 1840 he made a West Indies cruise aboard the *Brandywine*. On the short trip 488 became ill, mostly with typhoid, scarlet fever, pneumonia and malaria. Barton wrote a work entitled, 'Hints for Medical Officers Cruising in the West Indies.' In 1830 he was ordered to the Naval Hospital at Norfolk which had just been completed. The following year he returned to Philadelphia as senior member of the Naval Examining Board. In 1841 he advocated the keeping of a complete journal of all patients. The next year (1842) several new bureaus were formed and Barton was chosen the first Chief of the Bureau. Although the first Chief, Barton was not the first surgeon general of the Navy as the title was not created until 1869. He had many staunch friends; also, many bitter enemies who resented his spirit of reform. His 'liquor circular,' limiting the use of medical liquor on shipboard, caused feeling to run high in the fleet. In 1844 he resigned . . . his office [and] he served at the Pensacola Naval Hospital for about four years. He then became senior member of the Examining Board at Philadelphia. He remained in this position until his death, March 27, 1856." (T. S. W., *Am. J. Surg.*, 17: 451, 1932.)

Bilobed Gallbladder (Fellea Vesica Divisa)

JOHN J. HUDOCK, M.D., *Newark, New Jersey*, AND MICHAEL J. O'GRADY, M.D., *Belleville, New Jersey*

From the Department of Surgery, St. Barnabas Medical Center, Newark, New Jersey.

CONGENITAL duplication of the gallbladder is quite rare. A review of the literature revealed a paucity of material on this subject which prompted this report.

Boyden [2] has classified congenital duplications of the gallbladder into two main groups, namely, double gallbladder and bilobed gallbladder.

Double gallbladder (fellea vesica duplex) denotes a complete duplication of the gallbladder. By definition, in this condition there must be two separate and distinct gallbladders which may or may not have a common serosal coat but each gallbladder must be drained by its own cystic duct. The manner in which the cystic ducts unite with the common duct can and does vary. This is the most commonly seen type of gallbladder duplication and has been recently discussed by Moore and Hurley [11].

The second group and the one with which we are concerned herein, is the bilobed gallbladder (fellea vesica divisa). In this entity there is an incompleted duplication of the gallbladder. The two cavities found in this condition are drained by a single cystic duct. Two types of this anomaly are found, septal and V-shaped. In the septal type, the gallbladder appears normal to external inspection but when opened, a longitudinal septum of variable length will be found dividing the organ into two chambers of equal size. These cavities are drained proximally by a single cystic duct. In the V-shaped type, there is a complete division of the fundic and corporeal portions of the gallbladder into equal or unequal lobes, with fusion at the neck which is drained by a single cystic duct.

EMBRYOLOGY

The embryological explanation for the formation of a bilobed or bifid gallbladder has been demonstrated in the cat by Boyden [2]. In the cat, the embryonic gallbladder frequently acquires a paired form by subdivision of its primordium. When this structure is in the solid stage, a splitting in the longitudinal direction changes this single bud into a partially divided organ. These paired buds maintain a connection with each other but the fundic ends remain separated. The bilobed gallbladder in which two cavities are separated by a longitudinal septum probably represents an incomplete resolution of the solid stage through which a forming gallbladder normally passes. Instead of the entire cavity being re-established again, a portion of the solid elements remain to form a fold or septum.

ANALYSIS OF CASES

Bilobed gallbladder is commonly seen in high vertebrates, i.e., cats, but is seldom seen in man, being less in incidence than other segments of the extra hepatic biliary tree [10]. Table 1 shows the number of cases including the case reported herein, that we were able to find in our search of the literature. All other reported cases which had been seen only on roentgen examination and not verified at surgery or necropsy were excluded. All questionable cases, or cases as discussed by Stolkind [16] in which hourglass gallbladders with marked inflammatory changes were reported as bilobed gallbladders, were excluded.

Table 1 lists only those cases which conform to the criteria of a bilobed gallbladder as purposed by Boyden [2] and Gross [4]. Two cases, Deaver's [3] and Stolkind's [16] were incidental autopsy findings so that only eight clinical cases have been reported.

Upon analyzing these few cases, it becomes immediately apparent that there are no distinguishing features which permit clinical differentiation from other cholecystopathies. Occasionally, diagnosis can be made by cholecystograms as in a case reported by Hilt [6], in

TABLE 1

Author	Year	Sex and Age	Symptoms	Lithiasis	Type of Gallbladder
Deaver, J. B. and Ashhurst, A. [3]	1913	F, 55	Autopsy finding	Yes	V-shaped, unequal lobes
Rycroft, B. W. [13]	1923	F, 42	Biliary colic for 13 yr., jaundice	Yes	Septal type, equal lobes
Meyer, A. W. [8]	1926	F, 55	Biliary colic and jaundice	Yes	Septal type, equal lobes
Phillips, E. W., Isaac, D. and MacDonald, J. [12]	1931	M, 48	Jaundice and acute pancreatitis	No	V-shaped type, unequal lobes
Stohr, R. [15]	1934	F, 19	Biliary colic	No	V-shaped type, unequal lobes
Weiss, S. [17]	1935	.....	Biliary colic	Yes	V-shaped type, unequal lobes
Hilt, L. [6]	1937	F, 37	Biliary colic	No	V-shaped type, equal lobes
Stolkind, E. [16]	1939	M, 53	Autopsy finding	No	Septal type, equal lobes
Guyton, W. L. [5]	1946	F, 42	Acute cholecystitis	Yes	V-shaped type, unequal lobes
Case presented herein	1958	M, 63	Biliary colic, jaundice	Yes	Septal type, equal lobes

which two rows of gallstones were visualized and separated by a septum; this was verified at surgery. Alexander [1] has shown that cholecystography at times may be misleading. With the newer dyes being made available and advocated for the specific visualization of the extrahepatic biliary ducts, it seems to be within the realm of possibility that more cases may be diagnosed preoperatively than was previously possible.

The clinical signs and symptoms presented by these patients are essentially those which are found in the usual cases of acute, subacute and chronic cholecystitis, with or without stones. Cholelithiasis was present in six patients and three of these had jaundice. One other patient with acute pancreatitis also had jaundice. Six cases occurred in females and three in males. The age range was from nineteen to sixty-three years with the majority of patients being in the fourth and fifth decades of life. As to the type of bilobed gallbladder present, the septal type was found in four cases and the V-shaped type in six cases with unequal lobes being noted in five of these.

CASE REPORT

A sixty-three year old, 153 pound white man was admitted to the hospital on February 9, 1955 for a cholecystectomy. He was known to have had rheumatic heart disease since the age of twelve. Eighteen months previously, congestive failure developed which was treated at home with digitalis and bed rest. Six weeks prior to his admission symptoms of gallbladder colic developed for the first time with transient jaundice of one day's duration. He had no dark urine or light colored stools. He was treated with antispasmodics and placed on a low fat diet. Following recovery from this episode a cholecystogram showed cholelithiasis and surgery was advised.

The abdomen was entered through a right upper paramedian incision. Palpation revealed the gallbladder to be filled with many small stones. The common duct was inspected and palpated. It did not appear to be dilated and no stones were felt.

The cystic artery and duct were visualized, isolated individually and doubly ligated and cut. At this moment the blood had become dark and the cardioscope showed fibrillation. The chest was entered through the left fifth interspace and on palpation the heart was fibrillating. Normal rhythm was established by massage and stimulation with an electric defibrillator. While attempting to remove the gallbladder with traction on the fundus, the heart began to fibrillate again. The defibrillator was again used and normal rhythm established. The gallbladder was quickly removed from below upward, and hot saline pack placed against the liver bed.

Again the heart began to fibrillate; for the third time the defibrillator was used. The abdominal wound was closed with through-and-through silk sutures and the penrose drain to the gallbladder bed was brought out through the lower portion of the wound. The thoracotomy wound was closed and a catheter connected for underwater drainage.

Extubation was carried out in the recovery room. By the evening of the operative day, the patient had fully recovered and appeared to be normal mentally.

Postoperatively, he was given digitalis and large doses of penicillin. On the fourth postoperative

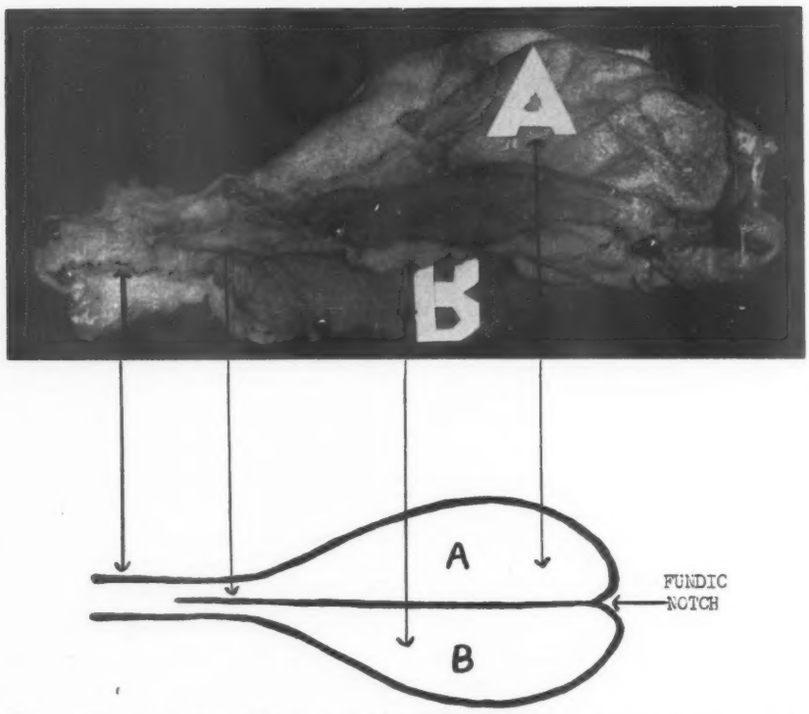

FIG. 1. Photograph and diagram of bilobed gallbladder. Arrows indicate (left to right) cystic duct, septum between lobes, mucosal surface lobe B and mucosal surface lobe A.

day, a skin rash developed, the penicillin was discontinued and the rash subsided. On the twelfth postoperative day swelling of the right leg and thigh associated with calf tenderness developed. Anticoagulants were given until March 3, 1955 with a good response and he was discharged on March 5.

He was followed-up for twenty-four months and had no episodes of jaundice or residual cerebral damage.

On pathologic examination, the gallbladder specimen measured 5.5 cm. by 10 cm. The outer surface was smooth and a small notch was seen in the fundic area. Upon sectioning the gallbladder, two cavities were noted, each filled with numerous yellow-green, 2 to 4 mm., faceted gallstones. The cavities were separated by a septum measuring 3 mm. in diameter. On either side of this septum which extended to the single cystic duct present, mucosa was noted. (Fig. 1.) Each cavity was equal in size and contained thick green bile in addition to the gallstones. The cystic duct did not contain any stones and was patent. On microscopic examination, it was noted that the septum was lined on either side by a single layer of cuboidal cells. The central portion of the septum was edematous and composed of fibrous tissue with lymphocytes. The mucosal lining away from the septum showed autolysis with absence of epithelial lining in some areas.

COMMENTS

The bilobed gallbladder must be differentiated from the more common double gallbladder and the diverticulum of the gallbladder [14]. Except for the fundic notch frequently seen, the septal type of bilobed gallbladder will not be recognized until the gallbladder is removed and examined. Grossly, this has the outward appearance of a normally formed gallbladder. The V-shaped type of bilobed gallbladder may present some difficulty but can be differentiated from the double gallbladder in that it communicates with the common bile duct through a single cystic duct.

Diverticulum of the gallbladder may be found in any position along the surface of the organ from the fundus to the neck, the commonest site being Hartman's Pouch [7]. In this condition, the gallbladder has one large cavity with one or more small cavities connecting with the true gallbladder. Few have been observed at operation.

SUMMARY

Bilobed gallbladder is a rare congenital anomaly in man and only ten cases have been

reported in the literature. Two types of the anomaly found are the septal and V-shaped type. There are no clinical signs or symptoms attributable to this anomaly which serve to distinguish it from other cholecystopathies. Treatment consists of removal of the diseased gallbladder after examination and exploration of the common bile duct as indicated.

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Peritoneal Mice

E. T. McCartney, M.C., M.B., F.R.C.S. and I. Stewart, M.D., *Yorksbire, England*

From the Victoria Hospital, Keigbley, Yorksbire, England.

For the last hundred years a remarkable amount of interest has been bestowed on the structures very occasionally found lying free in the peritoneal cavity. The three names which have been applied to them are foreign bodies, loose bodies and peritoneal mice. They are all unsatisfactory and the last has been selected because the other two are apt to carry the inference of forgotten surgical impedimenta. They may be defined as "fibrinoid, fatty or calcareous bodies arising as a result of organic change within the peritoneal cavity and lying free within it."

They have various origins. In 1927, Johnstone [3] described a calcified mass the size of a hazel nut lying in the peritoneal cavity of a woman who had had repeated abdominal operations. The left ovary was missing and histological examination of the surface of the mass showed some patches of cuboidal epithelium resembling that of the ovary, suggesting that the body was derived from the detached organ. According to Johnstone, Bland Sutton encountered detached subserous uterine fibroids and Halliday Croom reported a detached ovarian cyst and also an encysted mass of blood clot, probably derived from a tubal abortion. Johnstone mentions that in the years 1854 to 1860, nine instances of these peritoneal mice were shown to the Pathological Society of London and in one case an appendix epiploica undergoing torsion was observed at the same time by Wilks.

In 1919, Hunt [2], in an article devoted to torsion of the appendixes epiploicae found forty-two cases in the literature and also eleven cases of loose bodies in the peritoneal cavity. Only one author, Virchow [6], produced evidence of an association between the two conditions. In 1917, Harrigan [1], also writing of torsion and inflammation of the appendices epiploicae described a single case in which torsion necessitated urgent laparotomy and gave a list of authors describing peritoneal mice found at operation or postmortem examination. These were: Littre, Laveran and Cruveilhier who had no evidence of the origin of the structure; Virchow, in whose patient the only evidence was an atrophic appendix epiploica on the tip of the vermiform appendix; Schede, in whose patient a calcified mass in the pelvis was "found to be a calcified appendix epiploica" but who gave no indication of why it was thought to be one; Tomellini, who found a fatty mass attached to an appendix epiploica by a thin pedicle; Neri, who found several loose bodies composed of fatty tissue at laparotomy; and Riedel. The last named said of his four cases that in one, the bodies "were formed from appendices epiploicae," in the second, no source was suggested, in the third, two fatty bodies of unknown origin adhered to the under surface of the liver and in the fourth, in which no foreign body was found, there was a grey appendix epiploica which was presumed to have caused peritonitis.

It will be seen that of these eleven cases only those of Virchow, Tomellini and Riedel are at all suggestive.

In 1948, Ross and McQueen [4] reported the finding of a peritoneal mouse in a sixty-nine year old man suffering from nausea and constipation. A hard smooth lump was felt to the left of the umbilicus. At operation, after incising the omentum, a smooth white ovoid mass weighing 67 gm. was extruded. This was found to have a core of calcium phosphate encased in fibrinoid layers. There were adhesions between the pylorus and the liver and, at postmortem examination two months later, a healed duodenal ulcer was found. The authors considered that the structure might have arisen from the extrusion of foreign matter through the perforation in the ulcer. These authors also men-

tioned the discovery, in a dissecting room corpse, of a loose body the size of a pea and an appendix epiploica with a constriction in its centre and on the verge of separation.

Shepherd (1951) [5] saw a seventy-nine year old man in whom a hard stony mass, an inch in diameter, lying in the rectovesical pouch, produced an acute retention of urine. The structure had a flint-like core enclosed in fibrinoid layers. The origin of this was unknown.

CASE REPORT

CASE 1. A man of thirty-two years of age was admitted to the hospital with a forty-eight hour history of pain in the lower part of the abdomen radiating to the root of the penis. He had had no vomiting or disorder of micturition. The pain was intensified when he walked.

When examined, the tongue was clean and he had a temperature of 99.2°F. There was marked tenderness and guarding in the right iliac fossa and slight tenderness in the left iliac fossa. The urine was clear and rectal examination elicited tenderness in the rectovesical pouch.

A tentative diagnosis of appendicitis was made and laparotomy performed.

A "gridiron" incision was made. The caecum was not in the right iliac fossa. A peritoneal mouse was removed from the pelvis and a gangrenous torsion of an appendix epiploica found and removed from the anterior wall of the rectosigmoid junction. (Fig. 1.) The caecum lay high up due to non-descent. The appendix was mildly inflamed and fibrosis was occurring at the tip. Appendicectomy was performed.

Comment: In this case the mouse was 2.0 cm. in length, ovoid, hard and white. An x-ray film showed several nodules of calcification at its core. The presence of the gangrenous appendix epiploica, although not conclusive, was considered to be strong evidence of its origin. As can be seen from the review of the literature which has been given, the conjunction of the two conditions has only been recorded on rare occasions and in only one or two cases is the association equally convincing.

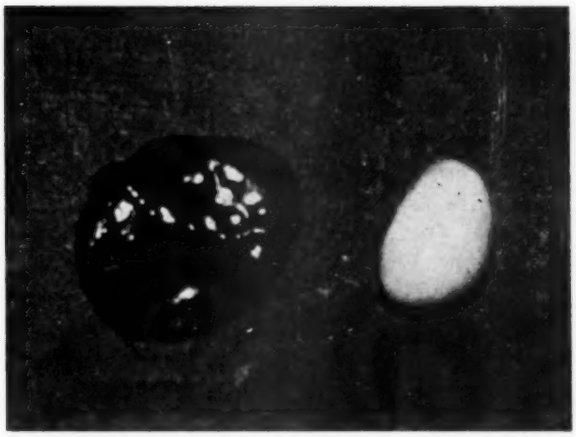

FIG. 1. The gangrenous appendix epiploica is seen on the left and the peritoneal mouse on the right.

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Benign Renal Angiolipoma

ALFONSO DE LA PEÑA, M.D., AURELIO C. USON, M.D.* AND MIGUEL OLIVEROS, M.D.,
Madrid, Spain

From the Department and Chair of Urology, Madrid Medical School, Madrid, Spain.

BENIGN renal tumors of clinical importance are extremely rare in both adults and children. For this reason, we wish to report a case of benign, massive angiolipoma of the kidney in an adult female, recently treated by one of us (A. P.). This case is the first benign renal angiolipoma registered in the pathological files of the University Urological Clinic of Madrid, whereas over 200 primary renal neoplasms are entered.

From the pathological standpoint benign renal tumors are made up of epithelial, mesenchymal and mixed (epithelial and mesenchymal) neoplastic elements. Their size varies from that of a little less than a low power microscopic field to that of 15 to 20 cm. in diameter and even larger. The small tumors are single or multiple and are usually distributed throughout the renal cortex (adenoma) or in the medullary zone near the neck of a calyx (fibroma). These two types are clinically silent and are occasionally discovered as an incidental finding at necropsy or in surgical specimens removed for another pathological lesion, e.g., renal tuberculosis, nephrolithiasis, etc. Fuchsman and Angrist [24] encountered seventy-nine such tumors (fifty were epithelial and twenty-nine mesenchymal) among 3,456 consecutive autopsies performed at the Queens General Hospital, Jamaica, New York. On the other hand, benign renal tumors which reach a larger size and produce symptoms, as occurred in our case, are very rare. They are usually misdiagnosed as being malignant neoplasms or cystic renal lesions, and thus are treated by renal exploration and/or nephrectomy. According to Foster [23], a total of only 135 cases of benign renal neoplasms in adults and children which were large enough to induce significant clinical symptoms and/or findings, has been published in the medical literature. The following were the pathological diagnoses in these 135 cases: adenoma in fifty-seven, angioma in seven, fibroma in seventeen, lipoma in twenty-four, myoma in twenty-two and mixed tumors in eight. Of these 135 cases collected by Foster, fourteen were in children, but this figure does not include the second case of the two reported in 1957 by de la Peña et al. [20]. In 1952 Spillane et al. [59] stated that no more than eighteen nephrolipomas have been described or reported from surgical specimens. In 1955 Brody and Lipshutz [7] collected from the medical literature forty cases of nephrolipomas, excluding from this figure the "capsulomas" or perirenal lipomas. They stated that most of the nephrolipomas showed a varied histological composition, e.g., fibrolipomas, angiomyolipoma, etc. A similar view of this had been expressed by Watson [63], Heckel and Penick [26], and others.

Several etiopathogenic theories which would explain the origin and development of benign intrarenal angiolipomas have been proposed, but there is no general agreement as to how these theories operate. Some workers consider these benign renal tumors as congenital errors or malformations, while others believe that they are true neoplastic growths. In 1948 Fuchsman and Angrist [24] stated: "The adenomyomas, fibromyolipomas and the other permutations and combinations of epithelial and stromal tissues may properly be considered differentiated forms of Wilms' tumors." The renal parenchyma has no genuine adipose tissue. Therefore the genesis of the lipomas is an intricate one. Lower and Belcher [38] in

* Present address: Squier Urological Clinic, Columbia-Presbyterian Medical Center, New York, New York

1927 mentioned that Alsberg and Selter were of the opinion that the renal lipomas come from embryonal "inclusions" of lipoid cells or from the fatty stromal tissue separating each reniculus. Hunt and Simon [*31*] and others think of lipomatous metaplasia of the perivascular and interlobular connective tissue cells. Robertson and Hand [*54*] suggest that such tumors originate from embryonal connective tissue surrounding the collecting ducts. According to Bell [*3*], the smooth muscular tissue found in the intrarenal lipoma comes from the musculature of the wall of blood vessels or renal capsule. In intrarenal lipomas the fatty cells and composition of their lipoid material are said to be different from that observed in "secondary" renal lipomatosis in the obese or in replacement lipomatosis of the kidney found in some cases of nephrolithiasis, pyelonephritis, etc. The distinctive vascular network which separates the fatty lobes in the true renal lipomas may occasionally proliferate further and develop into hemangiomatous tumors. Thus a pathologic diagnosis of hemangiolipoma rather than pure renal lipoma or hemangioma may be justified. In addition to fat and blood vessels, smooth muscular fibers originating from the wall of the blood vessels are usually present. Therefore these tumors are called angiomyolipomas and have been described in the past under the name of hamartoma or "error tumor," a term coined by Albrecht [*1*] in 1904. The origin of the hamartomas is unknown; however, the hypothesis that these tumors have an embryologic origin is shared by most of the workers in this field. As a result of the "embryologic error," apparently too many elements of otherwise normal tissue accumulate and become displaced in one or several organs and then proliferate to reach a size which at times is large enough to cause bizarre clinical symptoms or findings.

The recognition and correlation of a number of clinical syndromes associated with these mixed renal tumors appear to corroborate the hypothesis regarding the embryonal origin of hamartomas, angiomas and lipomas. In the tuberous sclerosis complex or Bourneville-Brissaud syndrome neurological, cutaneous and visceral disturbances are usually present. Single or multiple benign tumors in the lungs, retina, heart and face (Pringle's sign) are found in addition to the hamartomas or liposarcomas of the kidney. According to Critchley and Earl [*19*], renal tumors are present in 80 per cent of the patients with the syndrome of tuberous sclerosis complex. Pratt-Thomas encountered, at autopsy, multiple hamartomas in both kidneys and in the heart of a premature stillborn child. Renal liposarcomas also have been found and reported in patients suffering from tuberous sclerosis. In 1895 von Hippel [*62*] described the lesion of retinal angiomatosis, and Lindau [*36*] later demonstrated that in such cases angiomatous tumors in the cerebellum, kidney, pancreas, etc., may also be present. This combination has been known thereafter as the von Hippel-Lindau syndrome. In 1942 Cahill, Melicow and Guerry [*9*] reported on a patient with von Hippel-Lindau syndrome who had a large renal hemangioblastoma.

In addition to the described Bourneville-Brissaud and von Hippel-Lindau syndromes, benign renal neoplasms may mimic local (renal) symptoms and findings which are typical of any expanding benign or malignant renal lesion. Thus hematuria, abdominal mass, flank pain with or without tenderness and general systemic reactions such as fever, leukocytosis and an increase in the erythrocyte sedimentation rate may be present. Although this may be the case, a clinical diagnosis of benignity in the presence of an expanding renal mass should always be regarded with caution. On the other hand, the possibility of malignancy should always be considered in such cases, for which reason renal exploration is recommended. Furthermore, it should be emphasized that even in cases in which there are "so-called" typical urographic findings of a solitary renal cyst with excellent oxygen or CO_2 perirenal infiltration and delineation of the renal mass, absence of "puddling" in the aortogram and with a definitive punch-out rounded negative shadow as visualized in the nephrotomograms, such lesions may nevertheless be malignant. Finally, although it is possible to arrive at a pathological diagnosis of an expanding renal lesion by means of translumbar needle biopsy of the involved kidney, such a procedure is inadvisable because of the danger of seeding neoplastic cells. On the other hand, surgical exploration not only affords adequate diagnosis but also paves the way for cure by complete excision of the tumor.

1 2

FIG. 1. A forty-minute intravenous urogram from patient F. S. M. The right kidney and ureter are normal. Expanding lesion involving the left kidney, distorting the pyelocalyceal system and tilting the kidney slightly down and inward. The psoas shadow is obliterated.

FIG. 2. Left retrograde pyelogram from the same case. The collecting renal system and entire ureter are well filled and visualized. The pyelocalyceal deformity is typical of an intrarenal mass encroaching upon the superior and lower major calyces.

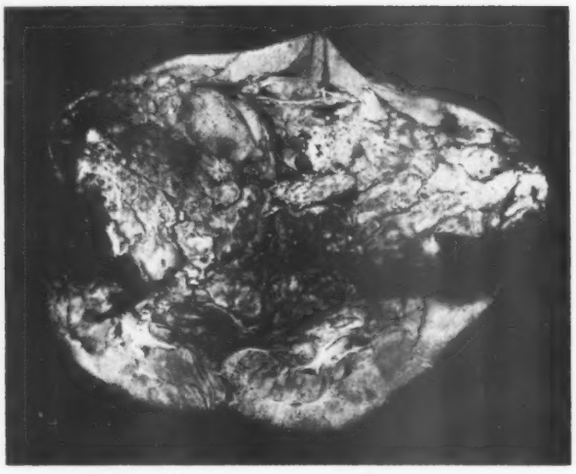

FIG. 3. Bivalved specimen, total weight 442 gm. Note the large renal growth involving the mid-renal segment. The upper and lower renal poles, as depicted in the urographic studies, appear uninvolved. The tumor seemed to be well encapsulated.

CASE REPORT

F. S. M. (C. H. 9661), a fifty-four year old married woman, was admitted to the hospital on July 8, 1957, with the chief complaint of gross hematuria for six days and recurrent attacks of pain in the left flank for two days prior to admission. The patient had been in good health until two months before her present illness, when a persistent mild elevation of the temperature was discovered.

Physical examination showed no abnormalities except for the evidence of blood in the urine. The blood pressure readings were normal and the temperature (sublingual) was 37.5°C. There were no palpable abdominal masses or tenderness at the costovertebral angle.

The results of the pertinent laboratory studies were as follow: Complete blood count and differential were normal and blood urea nitrogen was also within normal limits. The erythrocyte sedimentation rate was 63 mm. in the first hour. The urinalysis showed many red blood cells in each high power microscopic field, but the urine specimen for Papanicolaou smear was negative for tumor cells. A plain film of the abdomen revealed a large left renal silhouette with obliteration of the left psoas shadow. An intravenous urogram disclosed a normal right kidney; however, the left appeared enlarged and with characteristic pyelocalyceal distortion consistent with an expanding intrarenal mass. (Fig. 1.) The left retrograde pyelogram confirmed these findings and a diagnosis of left renal tumor was made. (Fig. 2.) A "radical" left nephrectomy (including kidney plus perirenal fascial envelope) was performed through the Nagamatsu approach [45]. The postoperative course was uneventful and the patient was discharged on the ninth postoperative day. The specimen weighed 442 gm. After dissection of the perirenal fat a large, well encapsulated tumor involving the mid-segment of the kidney was found. (Fig. 3.) On cut section the tumor resembled a clear cell carcinoma. There was a projection of the tumor encroaching upon the renal pelvis between the upper and middle major calyces as depicted in the pyelogram. The microscopic diagnosis (by Dr. F. de Castro) was benign angiolipoma of the kidney. (Figs. 4 and 5.)

COMMENTS

There is a remarkable clinical and radiographic similarity between primary "renal cell" carcinomas and the various mesenchymal neoplasms of the kidney. A correct differential diagnosis can be achieved only by means of histopathologic studies. From a clinical standpoint the differential diagnosis is difficult or not feasible on the basis of our present diagnostic procedures. However, a suspicion of benign or malignant renal neoplasms of mesenchymal origin is justified in the presence of the Bourneville-Brissaud and/or von Hippel-Lindau

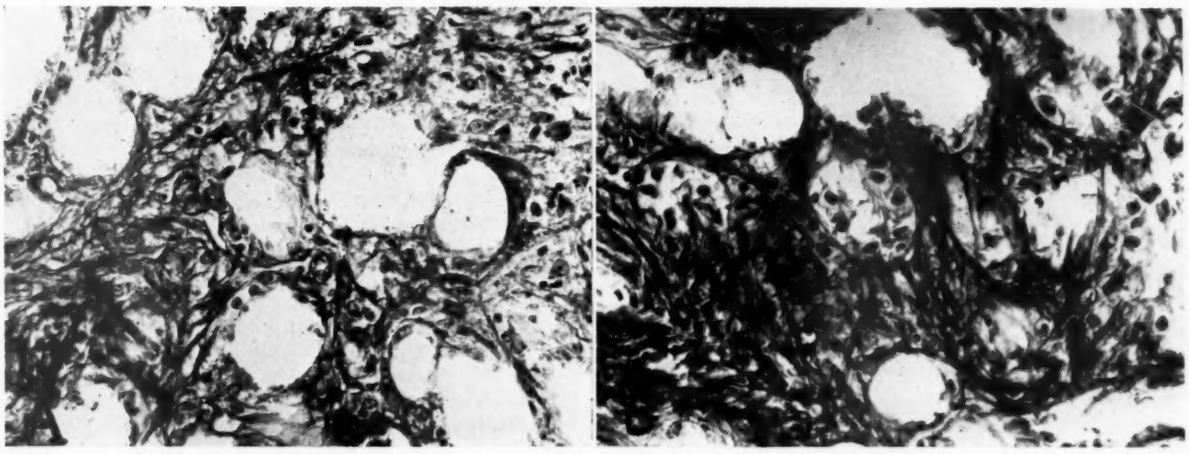

FIG. 4A and B. Photomicrographs from two different areas of the renal tumor shown in Figure 3. Note large number of wide capillaries surrounded by fibroblasts and connective tissue trabeculae (hemangiomatous component of the tumor).

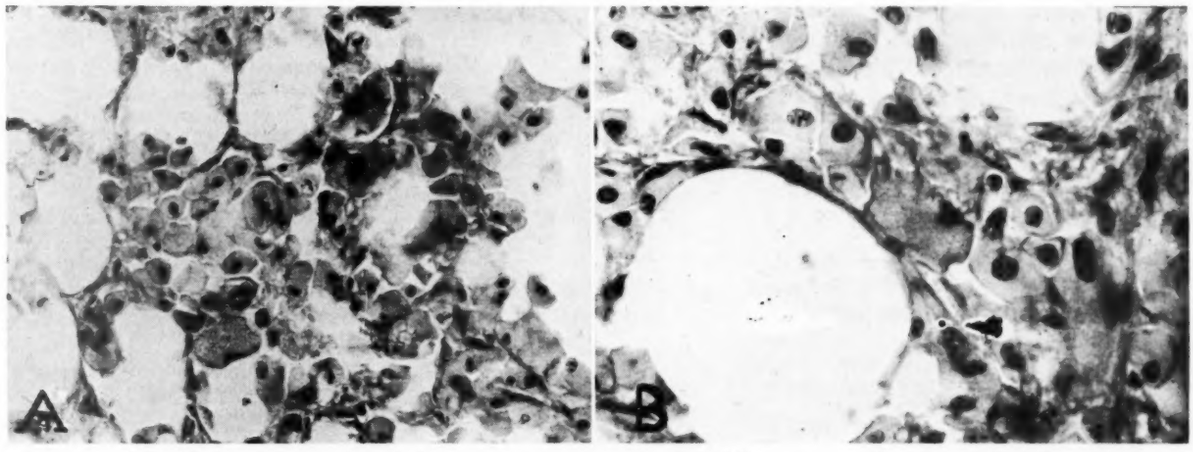

FIG. 5A and B. Photomicrographs of the same tumor area but of different magnification, taken from the renal tumor shown in Figure 3. Note numerous mesenchymatous elements (histiocytes) filled with tiny drops of primary fat and located in the vicinity of capillaries and adult adipose cells (lipomatous component of the tumor).

syndromes, particularly if there is evidence of an expanding renal lesion.

A distinction should be made between intrarenal lipoma and independent perirenal lipoma. The so-called intrarenal lipoma originates from the fatty cells found in the renal hilum. From here the tumor in its progressive expansion destroys the renal parenchyma by pressure atrophy and the tumor bulges and expands within the renal mass itself. At the same time it impinges against the renal pelvis between two major calyces, deforming thereby the collecting renal system. Perirenal lipomas are of two varieties. One is the so-called "capsuloma" which is well localized, of large size and usually displaces the kidney. The other is the diffuse perirenal lipoma which involves the entire Gerota's capsule, wrapping and compressing the kidney within a large shell of fat. Hypertension may be present in the latter form. Finally, the intrarenal lipoma must be differentiated from replacement lipomatosis of the kidney. The latter lesion is usually found with infected renal lithiasis, pyelonephritis, etc. The final diagnosis of these lesions is possible from tissue specimens only and not from the clinical data.

As the renal angiolipoma grows, it may produce pain secondary to intratumoral hemorrhage or distention of the renal capsule. The tumor may also produce pressure symptoms by pressing against the colon, duodenum, stomach, etc. It may cause intra- or perirenal bleeding by spontaneous rupture of tumoral

blood vessels and/or fever as a result of central necrosis and infection or as an anaphylactic reaction due to absorption into the blood stream of "foreign" proteins from the tumor. Because of the not infrequent bizarre clinical picture produced by these tumors, Creevy [*16*] in 1935 stated that renal tumors should be considered, with syphilis and tuberculosis, among the great mimics of clinical syndromes. Hempstead and Priestley [*27*] in 1952 suggested the necessity for obtaining an excretory urogram in all patients with fever of "unknown origin."

SUMMARY

A case of benign angiolipoma of the left kidney in a fifty-four year old woman is reported. The clinical, urographic and operative findings suggested primary renal cell carcinoma rather than a renal growth of mesenchymal origin. Neither cerebral symptoms characteristic of tuberous sclerosis complex nor the classical cutaneous findings were present in this case. The histopathologic studies of the specimen revealed a massive renal tumor made up of hemangiomatous and lipomatous benign elements. For this reason we believe that a pathologic diagnosis of benign angiolipoma of the kidney is justified and as such the case is reported.

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Incomplete Duplication of the Female External Genitalia or Double Clitoris

M. E. KURTH, M.D., *Chicago, Illinois*

CONGENITAL anomalies of the female external genitalia are rather rare except for the not uncommon but often unrecognized agglutination or fusion of the labia minora (synechia vulvae). The vulvar fusion is generally incomplete—a small, infraclitoral aperture permitting urination and later even menstruation in untreated cases. The labial union believed by some to be acquired from intrauterine inflammation [2] may be confused with imperforate hymen or congenital absence of the vagina and should be treated as soon as diagnosed, preferably in the neonatal period by simple division or separation of the midline adhesions by a probe without anesthesia.

Other described malformations of the female external genitalia include persistent cloaca (vulvovaginal anus), congenital vaginal cysts and vaginal prolapse, double vagina, and complete or partial absence of the vagina. Aplasia and hypertrophy of the clitoris and labia also occur as well as fissured or cleft clitoris in association with epispadias or vesical exstrophy. Another infrequent anomaly, the so-called "perineal groove," refers to a congenital depression connecting the introitus with an anteriorly displaced anal orifice [8].

Congenital hypertrophy of the clitoris, especially if accompanied by other abnormalities such as vaginal aplasia or partial penetration of the clitoris by the urethra, may produce a structure simulating a hypospadic penis, with hypertrophied labia resembling a bifid scrotum. Conversely, pseudovaginal types of hypospadias in the male further add to the confusion of sex determination. Hyperadrenalism affects the development of the genital tubercle from which the clitoris originates and may cause clitoral hypertrophy and female pseudohermaphroditism. Thus, extremely complicated and diagnostically puzzling situations of intersex may occur, requiring years of observation for their complete elucidation and even necessitating microscopic determination of the somatic chromosomal pattern, laparotomy with gonadal biopsy and hormonal assays, with the ever present problem of the failure of congruence of the anatomic and psychic make-up due to early environmental influences [7].

Congenital duplications of structures occur from time to time as represented by double thumbs or great toes, "mirror" hands, duplications of the intestine or stomach, double kidney, double uterus and even bicephalic terata or monsters. Spurious duplications are due to incomplete fusion of midline structures as in bifid or bifurcated uvula or bifid nose and tongue and are, of course, fissional defects rather than truly duplicated structures. Thus, a cleft or bifid clitoris due to an epispadias is not a true duplication but rather the result of failure of midline fusion of embryologic anlagen.

The ultimate form of duplication is represented by conjoined or Siamese twinning, and there may occur every conceivable degree of partial or asymmetrical conjoined duplications as when the "parasite" or smaller, imperfect twin is a shapeless, teratomatous mass attached to the jaw (epignathus) of the autosite or perfect twin. The parasite may also be a greater portion of a much reduced body but lacking a head, or may be an extra extremity such as a hand or lower limb protruding paradoxically from the trunk of the autosite. Duplications may represent abortive attempts at twinning and may be confined to the upper or lower half of the body. Gould and Pyle depict a case of duplication of both lower extremities with double vulva [3]. It would appear that almost any combination or variation that might be imaginatively conceived or mathe-

FIG. 1. External genitalia of four and a half year old child with incomplete duplication as represented by a double clitoris on the patient's right side. Note asymmetry of thighs and obliquity of left vulva.

FIG. 2. Normal genitalia on left side with introitus visualized but not present on right side.

matically predicted according to the laws of chance can be exemplified by reported, authentic cases. Ambrose Paré in the sixteenth century compiled a lengthy treatise on monsters depicting innumerable forms, some part animal, part human, part mythical, many highly grotesque and purely imaginative creations rather than based on carefully authenticated cases.

In the voluminous "Handbuch" by Halban and Seitz, double clitoris is mentioned briefly as the analogue of double penis [4] but is not illustrated, and few reported cases of this particular anomaly appear in the literature for which reasons the case reported herein was deemed of interest. Jeffcoate's [6] and Versteeg's [9] recent case reports with reviews of the literature are really cases of cleft clitoris associated with epispadias.

The relatively new field of experimental teratology has recently been given tremendous impetus by the laboratory production of monstrosities in animals by anoxia, insulin, cortisone, specifically deficient diets, radiation, and the use of radioactive isotopes. At critical stages of development cleft lip and palate and other anomalies can be produced in experimental animals almost at will, indicating that deprivation of essential nutriments or noxious intrauterine influences are as important as genetic transmission in the field of teratogenesis. The increased incidence of congenital anomalies occurring in women stricken with the otherwise innocuous disease of German measles during the first trimester of pregnancy is now generally recognized, and the reported occurrence of mongoloid offspring in pregnant survivors of the atomic blast at Hiroshima again emphasizes the extreme hazards of radiation exposure during pregnancy [5], and casts some light on this obscure and baffling anomaly.

CASE REPORT

This first-born child of perfectly healthy, normal parents in their thirties was prematurely and spontaneously delivered after an uneventful pregnancy during which there occurred no major surgery, gas anesthesia for dental extractions, auto accidents or x-ray therapy. The infant weighed 4½ pounds at birth and presented multiple, gross congenital anomalies including a lumbosacral spina bifida with neurogenic shortening and atrophy of the right lower extremity with clubfoot and genu varum. In addition, the external genitalia presented a most extraordinary, duplicated appearance with an accessory, papillary structure to the right of the normal but obliquely placed, non-midline genitalia. (Figs. 1 and 2.) The question of possible hermaphroditism was raised because of the penile-like appearance of the supernumerary organ. A moderate degree of hydrocephalus, as well as mental retardation, was noted. The child was kept in an incubator for three weeks and then transferred for institutional care at the age of two months. Mental and physical development was definitely slow but the child did eventually learn to talk intelligibly and walked in a waddling manner with the aid of a special shoe lift to equalize the length of the extremities. The child developed a pleasant, cooperative disposition, was easily manageable and most friendly and likeable.

Excretory pyelography on two different occasions revealed a normally functioning left kidney and ureter outlined down to the bladder but a complete failure of visualization of the right kidney, the shadow of which could not even be made out (Fig. 3), apparently due to a complete agenesis of that organ. Radiography of the spine disclosed numerous developmental anomalies including thoracic hemivertebrae, accessory rib and rotato-levo-

FIG. 3. Excretory pyelogram disclosing good visualization of the low-lying left kidney with total absence of right kidney shadow. Rotato-levo-scoliosis of lumbar spine with incomplete development of neural arches. "Split pelvis" with wide diastasis of pubic bones and right sacroiliac articulation.

scoliosis of the lumbar spine with incomplete closure of the neural arches of the lumbar area and soft tissue swelling due to the formation of a meningocele. A wide diastasis was present between the right iliac bone and the articular process of the sacrum, with a wide separation of the pubic bones as well resulting in a tilted, incomplete pelvic ring or so-called "split pelvis." Radiography of the lower extremities revealed retarded bone age of the ankles. The chest x-ray was within normal limits as were the skull projections. Other laboratory examinations disclosed no significant findings. Psychometric tests (Stanford) given when the child was 4 years and nine months old revealed an I.Q. of 68 on January 30, 1957.

It is believed that any deformity amenable to surgery should be corrected at the earliest optimal age if it can be performed without undue risk. Many deformities may have a profound psychological effect not only on the individual concerned but also on the immediate family and community as well. In particular, a deformity which renders an individual an object of ridicule, censure, curiosity or pity should demand first priority. The correction of such deformities should not be classified as "cosmetic" in the sense of a "beautifying"

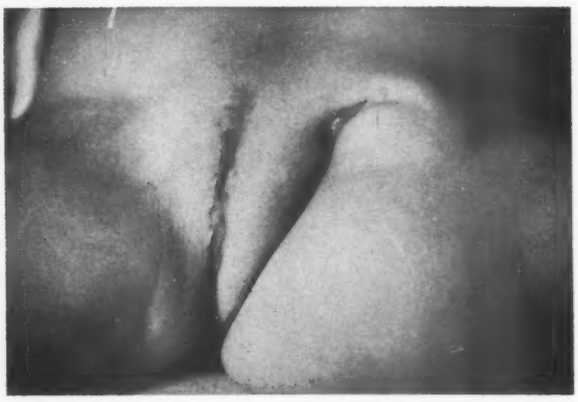

FIG. 4. Postoperative appearance of the genitalia after excision of the supernumerary clitoris.

procedure when the purpose is to create a more nearly "normal" appearance.

Accordingly, when the child was four and a half years old, she was placed under general anesthesia and vertical elliptical incisions were employed to remove the redundant structure. No undue amount of bleeding was encountered and a suspensory-like ligament was transected although no channel of any type was seen; the wound was closed in layers. The postoperative course was smooth and primary healing occurred. (Fig. 4.)

Pathological examination of the surgical specimen by Drs. M. L. Perou and Elizabeth A. McGrew disclosed a nipple-like elevation 1 by 1.5 cm. dimpled at its distal end but untraversed by any well defined tract. Microscopic sections were described as follows: "Normal skin covers a loose connective tissue stroma and forms two folds to produce a deep cleft. In the base of this is a small nodule also covered by squamous epithelium and composed of highly vascular tissue. The vessels are thin-walled and associated with many neural elements in a loose connective tissue stroma. This is consistent with erectile tissue such as that found in the clitoris. (Fig. 5.) Under oil immersion the Feulgen stained slides clearly show small condensations of chromatin on the inner surface of the nuclear membrane (Fig. 6) in the majority of these cells."

The recent demonstration by Barr [1] and other investigators of the value of oral smears, blood films and skin biopsies in the cytologic determination of chromosomal sex has established their usefulness in cases of congenital errors of sex development. The "chromatin-positive" or female-type nucleus is characterized by the adherence of a clumped XX chromatin particle to the periphery of the nuclear membrane which is absent in the "chromatin-negative" or male-type nucleus.

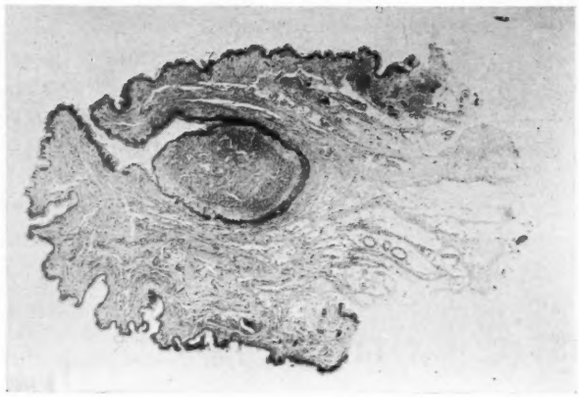

FIG. 5. Photomicrograph of double clitoris revealing preputial-like folds surrounding nodule of erectile tissue. (Courtesy of Dr. Elizabeth A. McGrew, Dept. of Pathology, University of Illinois.)

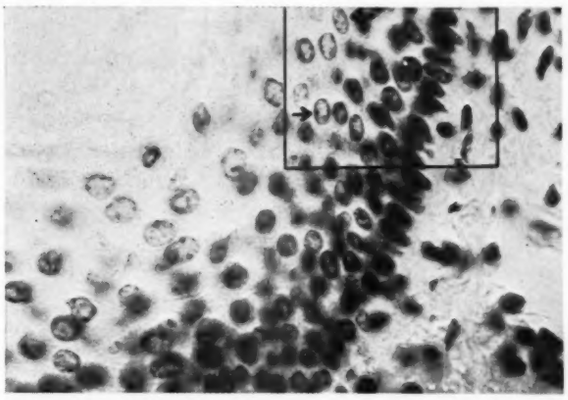

FIG. 6. Cellular details of microscopic section with typical female chromatin attached to nuclear membrane as indicated by arrows. (Courtesy of Dr. Elizabeth A. McGrew, Dept. of Pathology, University of Illinois.)

SUMMARY

A case is presented of a four and a half year old retarded girl with a unique combination of anomalies consisting of a lumbosacral spina bifida with atrophy and shortening of the right lower extremity, genu varum, thoracic hemivertebrae, accessory rib, diastasis of the symphysis pubis and right sacroiliac joint, agenesis of the right kidney and a duplication of the clitoris which was surgically removed.

Of interest embryologically is the partial duplication of a portion of the lower genitourinary tract coexisting with a unilateral agenesis of the upper portion on the same side with an asymmetrical, unstable, tilted, incompletely formed or "split pelvis" with a lumbosacral meningocele, re-emphasizing the rule of multiplicity in the occurrence of congenital defects in the same and unrelated organ systems. The demonstration of the characteristic female sex chromatin in the erectile tissue of microscopic sections of the surgical specimen aids in the elimination of the possibility of intersex. The absence of epispadias eliminates this as a case of cleft clitoris but rather one of a true partial duplication of the female external genitalia or double clitoris.

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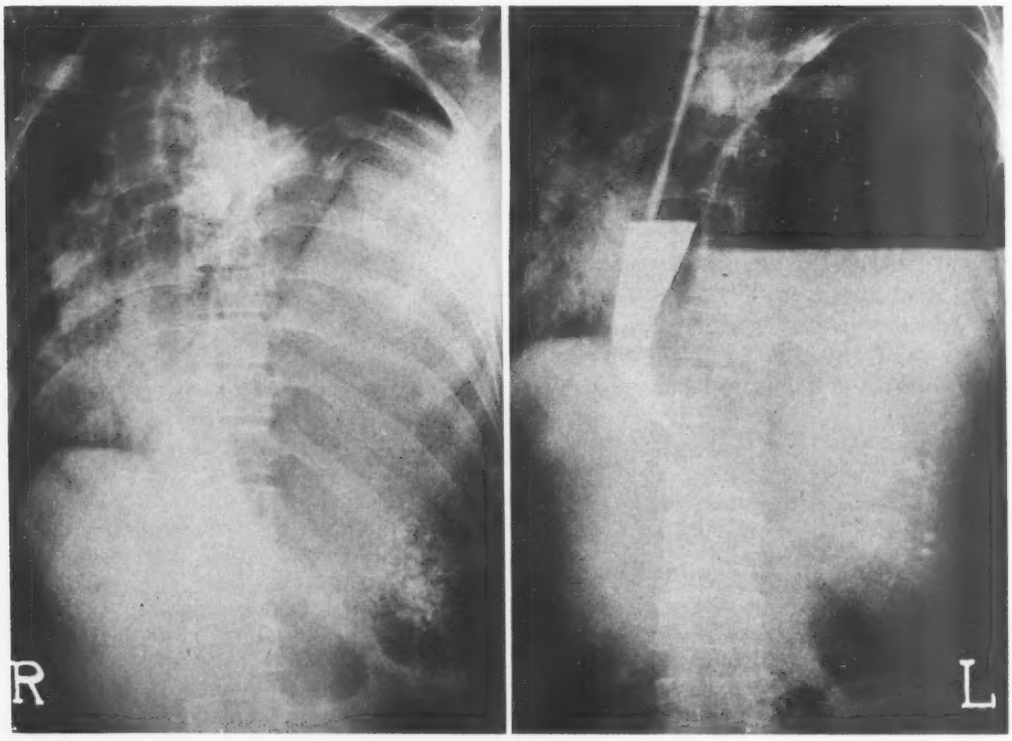
The Diagnostic Corner

A CLINICAL and radiological teaching exercise concerning an interesting acute surgical condition within the abdomen

SIDNEY W. NELSON, M.D., *Columbus, Ohio*

From the Department of Radiology, The Ohio State University, Columbus, Ohio.

THIS seventy-six year old Negro man was brought to the emergency room on January 23, 1956, with the history of having experienced on the previous day a sudden onset of pain in the left side of the chest and left shoulder, followed by vomiting. He had been unable to tolerate anything by mouth since the onset of his illness. His only previous hospitalization



Films with the patient supine and upright (discussed in text).

had been at another institution in 1933 following an automobile accident. This hospitalization lasted for a number of weeks, and he had experienced intermittent indigestion and difficulty in swallowing since that time. During the few years preceding his present admission he had experienced increasing dyspnea on exertion.

Physical examination on admission showed the blood pressure to be 140/100, pulse 100, temperature 99.8°F. and respirations 36. He was moderately dyspneic at rest and was in semi-stuporous condition. He was markedly dehydrated. The trachea was deviated to the right. There was dullness to percussion in the left side of the chest. The abdomen was somewhat distended and tense but no rigidity or rebound tenderness was elicited. There was a firm, ill defined mass in the left upper quadrant of the abdomen. A Levin tube could not be passed beyond the distal end of the esophagus, and orally ingested barium would not pass from the lower esophagus into the stomach even when the patient was in the upright position. An extremely large air-containing viscus was seen in the left side of the chest and left upper quadrant of the abdomen. These findings are well demonstrated on the foregoing supine and upright films. Findings are pathognomonic of an extremely grave situation demanding immediate surgical intervention. What is your diagnosis?

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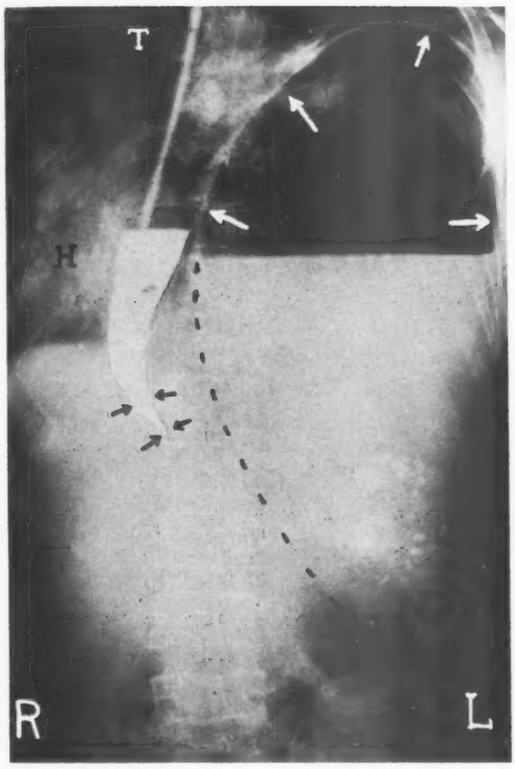
DIAGNOSIS: Organoaxial volvulus of the stomach which had herniated through a long-standing traumatic diaphragmatic hernia into the left pleural space.



The history of dysphagia and indigestion since the automobile accident in 1933 is certainly suggestive of a traumatic rupture of the left diaphragm with subsequent herniation of the stomach into the pleural space. Massive herniation of the stomach into the left pleural space is undoubtedly a predisposing factor in the production of some cases of acute gastric volvulus. The history of sudden onset of left-sided chest pain, pain in the left shoulder, and vomiting on the day prior to admission, with inability to retain any ingesta, are admittedly not specific for gastric volvulus. However, retching with inability to vomit on the day of admission in spite of a huge gas- and fluid-containing hollow viscus in the left upper quadrant of the abdomen and lower left hemithorax should suggest the possibility of a closed-loop obstruction of the stomach. The diagnosis is confirmed when radiographic examination shows a complete obstruction to the flow of the barium at the cardia, even when the patient is in the upright position. The gradual symmetrical tapering of the lower esophageal lumen to the point of complete obstruction at the cardia when associated with an adjacent huge dilated viscus is a well known and reliable sign of acute gastric volvulus, and is similar to the point of obstruction demonstrable by barium enema in patients with sigmoid volvulus.

The early recognition of *any* closed-loop obstruction is extremely important because the condition progresses rapidly to complete devitalization of the strangulated tissues. Although in the case presented herein the diagnosis of acute gastric volvulus was made following the radiographic examination and preparations were made for immediate surgery, the patient suddenly became dyspneic and died before anything more than an emergency gastrotomy could be performed in an attempt to decompress the enormously dilated stomach. Autopsy verified the antemortem diagnosis. There was no myocardial infarction, pulmonary embolus or other explanation for the sudden terminal episode of dyspnea, although the patient did have coronary atherosclerosis. Except for the distal gastric antrum, the entire stomach lay above the left hemidiaphragm, having herniated up through an 11 cm. long-standing rent. Death was probably due to a combination of factors including coronary artery disease, hypoxia due to compression of the left lung by the dilated stomach, and physiological changes due to the marked shift of the heart (H), trachea (T) and other mediastinal structures into the right hemithorax. The strangulated tissues of the stomach were still viable; and if the patient had come to the hospital a few hours earlier, it is probable that there would have been time to treat the volvulus successfully by surgery.

In summary, the important clinical and radiological diagnostic features of acute gastric volvulus are as follows:

1. Sudden onset of upper abdominal pain, distention and inability to retain ingesta.
2. Radiological evidence of high closed-loop obstruction, i.e., single huge loop of gut in upper abdomen, usually on left side.
3. Complete obstruction at the cardia to the flow of orally ingested barium.
4. Typical gradual symmetrical narrowing of

the esophagus to the point of obstruction at the cardia.

5. Patient retches, but cannot vomit in spite of increasing evidence of high closed-loop obstruction.

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Case Analysis Clinic

THE step-by-step management of an acute abdominal problem in an elderly patient has been analyzed for the reasoning behind each detail of surgical care

DAN W. ELLIOTT, M.D., *Columbus, Ohio*

From the Department of Surgery, The Ohio State University School of Medicine, Columbus, Ohio.

PATIENT L. C., a sixty-two year old white woman, was first seen in the Emergency Clinic approximately forty-eight hours after the onset of fairly severe, steady pain in the right upper quadrant of the abdomen, with radiation to the back just to the right of the midline. The pain had appeared gradually, several hours after her usual evening meal, and was followed by vomiting which contained food but no blood. The pain persisted as a dull, steady ache rather deep in the right upper quadrant, accompanied with anorexia. There was no change in the pain with respiration. Her bowels had not moved since the onset of pain, although normal movements had occurred up to the day of onset. Some three years earlier a bout of similar pain of brief duration had been diagnosed by her physician as a "gallbladder attack." There had been no further symptoms, minimal food intolerance, no recent indigestion nor weight loss. She was taking no medications. The past history and review of symptoms were unremarkable except for a pelvic operation twenty years earlier.

The patient had remained in her bed at home, sipping only small quantities of water. In the evening of the second day she was seen by her family physician, who believed the episode to be a recurrence of the gallbladder colic, but he sent her to the hospital because she seemed too ill for this explanation alone.

Pertinent Physical Findings. The patient was a moderately obese, elderly woman, appearing acutely ill but alert and complaining of generalized upper abdominal distress. Her blood pressure was 100/70; pulse rate, 114 and regular; respirations 24; temperature, 101.6°F. orally. The skin showed no jaundice but moderate dehydration. The chest was clear bilaterally. Heart tones were of good quality. The abdomen was moderately distended and diffusely tender in both upper quadrants. No distinct masses could be felt, although accurate palpation was not possible because of abdominal rigidity and tenderness. The liver edge seemed palpable about 2 fingerbreadths below the costal margin; pressure under the liver produced marked pain, with slight rebound tenderness, but this was not well localized. The costovertebral angles were not especially tender, and pelvic and rectal examinations added nothing. Stool in the rectum was of normal appearance and negative for occult blood. There was no peripheral edema.

Emergency Clinic Care. Venous puncture with a No. 18 needle was performed and blood was drawn for hematocrit, complete blood count, electrolytes: sodium, potassium, chloride and CO_2, blood urea nitrogen, serum amylase and a sample for cross matching. Two units of whole blood were requested. Through the same needle an infusion of 5 per cent dextrose in saline was begun. A voided urine specimen was obtained. This was only 40 cc. in volume and acid to litmus, with a specific gravity of 1.018, 1 plus protein, no sugar or acetone. Since the patient was not vomiting, a nasogastric tube was not inserted pending x-ray studies of the abdomen. She was placed on a stretcher lying with her right side up for transport to the x-ray department, with the saline infusion running.

Initial history and physical examination point to an abdominal inflammatory process, most marked in the right upper quadrant, and sufficiently severe to produce spreading peritoneal irritation and ileus. Systemic response is manifest by fever, dehydration and borderline shock, evidenced by the elevated pulse rate. The blood pressure of 100/70 may also indicate hypotension in an obese elderly woman. The next logical steps in diagnosis include x-ray examination of the abdomen while the laboratory is running a serum amylase test. Since enzyme determinations in blood, urine and abdominal fluid provide the best means of con-

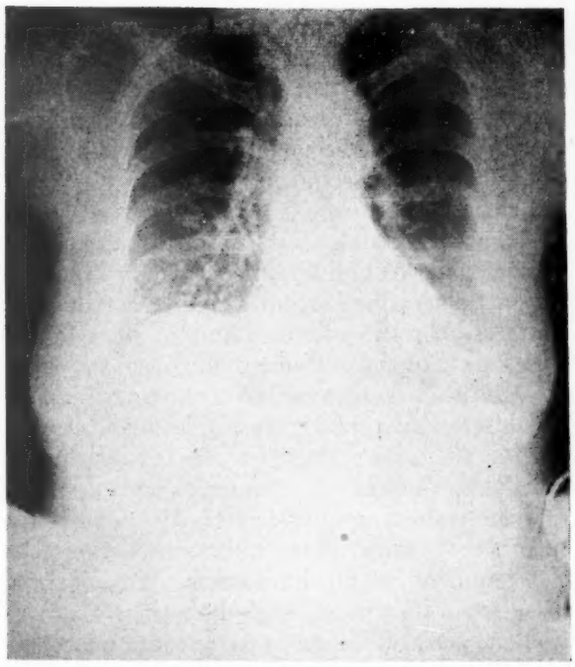

FIG. 1A. X-ray film taken on admission. The upright chest film shows blunting of the left costophrenic angle, suggesting mild pleural effusion. This is often seen secondary to abdominal inflammation from leaking ulcer or acute pancreatitis. There is no free air under the diaphragm.

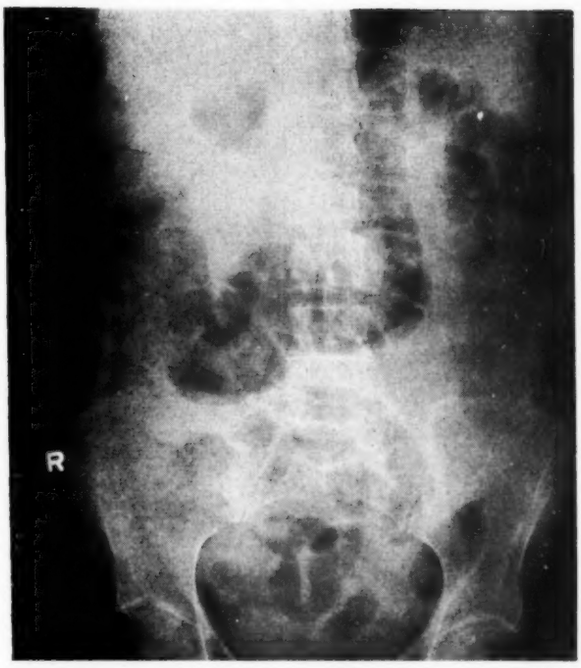

FIG. 1B. Flat film of the abdomen shows air-filled transverse colon and gas in the small bowel in the left upper quadrant and the pelvis, suggesting ileus. Distention of the transverse colon may be marked in acute pancreatitis.

firming a diagnosis of acute pancreatitis, the amylase is as important as the white blood cell count in managing this patient.

She was placed on a stretcher, lying with her right side up on the way to the x-ray department, so that any minimal amount of air in the abdomen would localize above the liver where it could be easily visualized by x-ray in either a right lateral decubitus or an upright film. After the patient has been in this position for ten minutes, as little as 2 cc. of free air above the liver can be demonstrated reliably by this method.

Dehydration was suggested by the patient's history of vomiting and anorexia for forty-eight hours, and physical examination confirmed this. When dehydration is present, extracellular fluid is missing, regardless of how the fluid loss occurred. Replacement of both water and isotonic amounts of salt are required. Therefore in dehydrated patients normal saline with 5 per cent dextrose is the first intravenous infusion started, and it should be started at once, without regard to the serum electrolyte concentrations. Normal saline will specifically correct that portion of shock due to dehydration, but it will not replace serum protein or whole blood loss. Therefore a cross match was drawn with the initial venopuncture.

At least 5 per cent of the patient's body weight had been lost as extracellular fluid, since detectable signs of dehydration were present on physical examination. Roughly, this would amount to perhaps 3 kg. or 3 L. of fluid. With a suggestion of borderline shock present, it was important that a needle be open in an arm vein, with saline running, and cross matching under way, before the patient was subjected to the manipulations of x-ray and transport to bed. No potassium was added to this initial infusion since the kidney function and urine output under the insult of this sickness was still unknown. There is almost no clinical situation in which potassium is needed before urinary output is known.

Laboratory Results. An x-ray film of the chest with the patient sitting showed only a suggestion of fluid in the left costophrenic angle. There was no free air under the diaphragm. Flat and upright films of the abdomen showed scattered gas within the small bowel with several air-fluid levels, but no distention. The transverse colon was filled with gas. No significant calculi were visualized. These films suggested paralytic ileus to the radiologist. (Fig. 1.)

FIG. 1C. An upright film of the abdomen showing scattered air-fluid levels confirmed the presence of ileus.

By the time the patient reached her hospital bed, reports were available of the initial blood studies. These showed: hematocrit, 49 per cent; hemoglobin, 15½ gm. per cent; white blood cell count, 17,000 per cu. mm., with 86 per cent neutrophils; blood urea nitrogen, 76 mg. per cent (normal less than 20 mg. per cent); serum amylase, 390 Somogyi units (normal less than 200); serum icterus index, 15 units (normal less than 10); serum sodium, 136 mEq./L.; serum potassium, 3.8 mEq./L.; serum chloride, 110 mEq./L.; carbon dioxide combining power, 17 mEq./L.

The initial saline infusion was followed by 1 pint of whole blood, and then 1 L. of ⅙ molar sodium lactate solution was started slowly. After the administration of these fluids the pulse rate slowed to 92 and the blood pressure rose moderately to 130/70; the patient appeared improved and voided 150 cc. of urine. She had not vomited but was complaining bitterly of increasingly severe pain in the upper part of the abdomen. Before adequate sedation could be safely given, decision had to be made about emergency laparotomy.

The x-rays and laboratory data so far have served only to confirm the previously recognized acute inflammatory process in the upper part of the abdomen. The serum amylase showed a borderline elevation to twice normal values. This finding is suggestive of acute pancreatitis but is far from conclusive. However, if this diagnosis could be established, a needless emergency laparotomy can be avoided, since operation accomplishes nothing for the acute stages of pancreatitis and can make a bad disease worse. On the other hand, non-operative therapy cannot be safely undertaken until other conditions requiring emergency surgery are clearly ruled out.

An accurate diagnosis of acute pancreatitis must usually rest on finding elevated pancreatic enzyme activity in serum, urine or ascitic fluid shortly after the sudden onset of pain in the upper part of the abdomen. Three major types of enzymes are secreted by the pancreas, i.e., amylase, lipase and trypsin, but amylase is by far the easiest and quickest to measure. However, marked elevations of serum, urine and peritoneal amylase activity have been recorded in many different abdominal emergencies requiring prompt operation. These include mesenteric infarction, high intestinal obstruction, perforated ulcer and gangrenous gallbladder. Such clinical cases, and laboratory studies as well, show that pancreatic enzymes enter the blood stream, and the urine later, by direct absorption from enzyme-rich fluid in the peritoneal cavity or from lymph draining the upper part of the abdomen. Any situation which allows digestive juices to enter the peritoneum can elevate serum, ascitic fluid or urinary amylase. Such juices can leak from a perforated ulcer or pass directly through the wall of gangrenous or compromised bowel. Bile leaking from a gangrenous gallbladder can contain large quantities of pancreatic enzymes if the pancreatic duct forms a common channel with the common duct. The pancreas itself weeps an ascitic fluid rich in enzymes early in the course of acute inflammation.

Serum amylase levels may also be elevated if the normal excretion of enzymes through the urine is interfered with. This can occur in far advanced nephritis, oliguria or uremia. This patient's blood urea nitrogen elevation is consistent with her dehydration, and this much uremia is not ordinarily sufficient to raise the serum amylase by itself. However, it is clear that all these conditions must be considered in explaining an elevated amylase in any body fluid.

Diagnostic Paracentesis. In view of the inconclusive history, physical examination, x-ray and laboratory findings, a diagnostic paracentesis was performed in the right flank just lateral to the most tender area of the abdomen. With procaine

locally infiltrated in skin and fascia, a No. 18 spinal needle was threaded gently through the peritoneum and 10 to 15 cc. of a murky yellow fluid readily withdrawn. Although red cells were present, the ascitic fluid was not generally hemorrhagic and had no appreciable odor. Foam was not distinctly yellow on shaking. A sample was sent to the laboratory for culture, smear and amylase determination.

In examining peritoneal fluid diagnostically, its character, color, odor and the presence or absence of bile or bacteria are at least as important as its enzyme content. In this case the absence of significant hemolysis, bacteria, frank hemorrhage or foul odor in this fluid weighed against the presence of compromised or infarcted bowel *at this time*. The absence of bile, as indicated by the pale yellow foam on the shaken sample, is against *open* perforation of an ulcer or a gangrenous gallbladder. Its yellow color, similar to serum, is consistent with acute pancreatitis of a mild to moderately hemorrhagic variety.

In peritoneal fluid of this character a high amylase level will strongly support a diagnosis of acute pancreatitis. Such a high amylase may be found for several days in ascitic fluid after serum levels have returned to the normal range, and this may have occurred in this patient. Amylase elevations in serum frequently disappear within forty-eight hours after the acute onset, even though the destructive process in the pancreas is actively progressing. Therefore, in the period between two and about seven days after the onset of pancreatitis, ascitic-fluid amylase determinations find their greatest diagnostic usefulness.

Although the peritoneal fluid of severe necrotizing pancreatitis may be as hemolyzed and bloody as that from any infarcted bowel, when such fluid occurs, the pancreatitis is overwhelming and induces shock before illness has progressed for forty-eight hours.

If no peritoneal fluid had been obtained laterally in the right upper quadrant of the abdomen, paracentesis would have been repeated in each of the other quadrants, in their most dependent portions. The absence of any peritoneal fluid at all would have helped exclude free perforations or gangrenous bowel, but would not have ruled out localized or encapsulated leaks.

Pancreatic lipase is said to remain elevated in serum and urine for longer periods than amylase. However, its determination requires a precisely standardized and unstable substrate, and a much longer period of time than does an amylase determination. These factors make it unavailable in most clinical laboratories. Reliable tests for pancreatic trypsin in the blood stream or ascitic fluid have not yet been developed.

In the management of her initial parenteral fluid therapy, the first saline infusion was followed by whole blood once this was available. This was a good supportive measure, regardless of the etiology of the patient's borderline shock, ileus and peritoneal irritation. It was necessary before laparotomy could be undertaken safely, in view of her elevated pulse rate. The blood was followed by ⅙ molar sodium lactate solution, because this provides "free base," or sodium without chloride. It was started before serum electrolyte values were known. This is good therapy for patients showing dehydration in which extracellular fluid volume must be restored. Extracellular fluid contains a ratio of three parts of sodium to two parts of chloride. The normal concentrations are the same as plasma: 144 mEq./L. of sodium and 100 mEq./L. of chloride. Since normal saline contains equal amounts of sodium and chloride, if it is given alone to correct dehydration, excessive amounts of chloride are given. Kidneys which are compromised by mild disease, dehydration or acidosis, as in this case, cannot easily excrete this excess chloride. It would be retained, tending to produce more acidosis. Therefore, in the logical correction of dehydration, about 1 L. of ⅙ molar sodium lactate should be given for each 2 L. of normal saline required. Sodium bicarbonate is equally effective in a ratio of two ampuls, or 80 mEq., for each *1 L.* of saline given.

When the laboratory results became available, showing a low CO_2 combining power and a high chloride, the presence of acidosis and the need for this excess free sodium was confirmed. While respiratory alkalosis could also have given these laboratory results, this can be ruled out by the clinical absence of any cause for *marked* hyperventilation and the finding of an *acid* urine.

Potassium chloride could be safely added to the intravenous fluids after the saline and lactate for rehydration had been given, and a satisfactory urine flow observed. This should be done, since total body stores of potassium can be depleted by vomiting and by either

acidosis or alkalosis. This depletion can contribute to prolonging ileus. As a general rule, acidosis raises serum potassium concentration, and alkalosis lowers it. In this patient's mild acidosis, if normal bodily potassium stores had been present, her serum potassium concentration would have been unusually high. The normal finding of 3.8 mEq./L. indicated some degree of potassium depletion.

Treatment for Acute Pancreatitis. When the laboratory reported 2,000 Somogyi units of amylase in the fluid obtained at paracentesis, the clinical diagnosis of acute pancreatitis appeared to be well supported. Non-operative therapy was decided upon for the time being. A nasogastric tube was passed, the stomach evacuated and constant gastric suction begun. Atropine, 0.4 mg., was given subcutaneously every six hours. Meperidine HCl (demerol®) was used in adequate amounts to achieve relief of pain, avoiding morphine. Vitamin K was given parenterally, and penicillin, one million units initially, was administered through the intravenous tubing. Three hundred thousand units of penicillin with ½ gm. of streptomycin was ordered for intramuscular administration every twelve hours.

Two ampuls of concentrated salt-poor human serum albumin, each containing 100 cc. or 25 gm., were attached to the present intravenous tubing and allowed to run in rapidly, and one additional unit was ordered for each eight hours thereafter.

After twenty-four hours of this supportive regimen, the pulse rate returned to 72, the blood pressure remained stable, urinary output was satisfactory and the abdomen seemed not so generally tender nor distended. Fasting blood sugar and serum calcium determinations were obtained the following morning and were reported to be within normal limits.

Treatment for acute pancreatitis is still nonspecific, symptomatic and supportive, but supportive measures of proved merit are available. It is clear that the acute process in the pancreas itself, in all but the most severe stages, is largely reversible. If the patient can be tided over the acute episode, the chances are excellent for restoration to good health.

The observance of some major principles in treatment will pay rich dividends.

1. The pancreas must be placed at rest as nearly as possible. There are two kinds of secretory stimuli to be prevented, hormonal and nervous. The hormonal stimuli arise from the duodenum upon contact with acid or food. Gastric suction not only minimizes this, but is good treatment for the accompanying ileus as well. Parenteral atropine, in an effective dose, is used in addition to prevent nervous or vagal stimuli for secretion.

2. Pain is controlled with meperidine HCl (demerol) or other narcotics with spasmolytic effect on smooth muscle. Morphine is avoided because of its tendency to provoke spasm of the sphincter of Oddi. Splanchnic blocks are rarely necessary. There is experimental evidence that they have a deleterious effect on pancreatic necrosis.

3. Prophylaxis for specific complications includes antibiotics. Although the initial pancreatic insult is undoubtedly sterile, secondary infection is common in compromised tissue or cysts. Infected acute cholecystitis or cholangitis may also be present, and cannot always be detected separately. Vitamin K is administered because the normal absorption of this element from the gastrointestinal tract is prevented by the ileus and antibiotic therapy. Prothrombin often falls in these patients and there is an increased tendency toward gastrointestinal hemorrhage as a complication of acute pancreatitis. Blood sugar levels are drawn regularly, since the pancreatic necrosis occasionally precipitates or accentuates diabetes mellitus. Blood calcium levels are also checked, since they may fall after several days. This is thought to be due to precipitation of calcium soaps in the abdominal fat necrosis usually present. However, this may also represent a specific endocrine response to pancreatic necrosis, since on rare occasions parathyroid hormone as well as calcium is necessary to prevent tetany. This complication carries a grave prognosis.

4. Perhaps most important of all is the provision of adequate albumin, plasma or blood for blood volume replacement. This must be done promptly, in the first few hours of treatment, as prophylaxis against shock, and *not* reserved until frank hypotension appears. If such shock develops, the resulting loss of blood supply to the pancreas can convert a mild edematous pancreatitis to a frank hemorrhagic necrosis. This has been demonstrated in experimental animals.

The need for blood volume replacement has been demonstrated by blood volume determinations, using radioactive technics, in more than thirty patients with early acute pancreatitis [1]. These determinations have shown

deficits averaging 1,500 cc. of whole blood whenever pancreatitis is accompanied with significant ileus or with peritoneal irritation. Deficits of this magnitude, developing within a few hours' time in the acute attack, do not permit physiologic compensations for blood loss to occur. The sudden appearance of shock in these patients is therefore not surprising, and experience has shown that in about one patient in six sudden hypotension will develop. These marked deficits are often unrecognized clinically, since they are accompanied by dehydration and plasma volume loss into the abdomen. The resulting hemoglobin and hematocrit readings are often normal or high, yet the circulating deficit is great.

Blood volume deficits are probably due both to edema and ascitic fluid formed in the pancreas, and also to the accompanying ileus. They have not been found in the very mild attacks of edematous pancreatitis, in which typical abdominal pain is accompanied with marked amylase elevations but no ileus. In these patients both pain and amylase subside quickly, and gastric suction is not required for longer than twenty-four hours. About one-third of our patients have had this sort of attack, which often subsides with very little treatment. Pathologically, in the pancreas, edema with a little fat necrosis is all that is found. In the remaining two-thirds of patients prolonged ileus, distention and blood volume deficits do develop and the patients often become gravely ill within a few hours' time. These are the patients with hemorrhage and necrosis in their glands. However, when each patient is first seen, it is impossible to determine into which group he will fall. The degree of amylase elevation may be just as high in either group and is no index of severity. For this reason it is probably wise to treat every patient with acute pancreatitis with adequate colloid for blood volume replacement. Two-thirds of the patients will prove to need it. In this patient's case, in which ileus was evident on the first examination, blood and albumin were clearly indicated.

The initial blood volume loss, early in the attack, is largely in the plasma component. Later the red cell mass becomes depleted. Concentrated human serum albumin provides ideal initial colloid therapy for these patients, since it effectively expands plasma volume. Because it is poor in salt, it is almost impossible to overload the circulation with it, even when given unnecessarily or in an excess amount. We have experienced no complications from its use. However, if it is not available, whole stored plasma should be used until the hemoglobin falls. For patients with an initial low hemoglobin, or in whom a later anemia develops, whole blood is indicated. We have used routinely in the first twenty-four hours, three shock units of albumin, (25 gm. each), or 1,000 cc. of plasma, or whole blood when indicated, and followed this with similar amounts daily until clear-cut improvement occurs.

The addition of effective colloid therapy to the standard therapeutic regimen has lowered mortality for all forms of acute pancreatitis, including the severe traumatic and postoperative cases, from 19 per cent in 1953 to a current average of about 6 per cent [1].

If this patient had failed to show prompt and continued improvement in her abdominal signs under these supportive measures, reevaluation of the diagnosis would have had to be made. This may include repeating the diagnostic paracentesis after eight or twelve hours. If improvement does not continue under treatment, while the diagnosis remains in doubt, exploratomy laparotomy will be clearly indicated. Occasional cases of acute pancreatitis must still be diagnosed at the operating table, either because of difficulty in establishing diagnosis or because of concurrent acute cholecystitis or other complicating problems.

Convalescence. Temperature elevations to 102°F. persisted for three days, but blood pressure and pulse rate remained normal. There was slow but steady improvement in the abdominal signs, with decreasing distention. On the third day of therapy active bowel sounds returned, and on the fifth a bowel movement occurred. As abdominal rigidity decreased, tenderness and a suggestion of a deep mass persisted and became localized in the epigastrium. Serum amylase remained elevated in the range of 400 Somogyi units, or twice normal values, and a slight elevation of serum bilirubin appeared. Finally, with the return of active peristalsis, gastric suction was discontinued on the fifth hospital day. Parenteral atropine was changed to belladonna by mouth. Antibiotics and vitamin K were continued. Liquids were allowed very cautiously, but with satisfactory progress, a bland ulcer-type diet could be taken by the seventh day. Antacids and plain milk were given between meals. Stimulants of gastric acidity, such as coffee, cigarettes, tea and colas, were scrupulously avoided. Blood sugars were followed and remained normal. The hemo-

globin gradually fell to 9.5 gm. per cent and a supportive transfusion was given.

By the tenth day, when the patient was up and about, eating reasonably well, the serum amylase and bilirubin had returned to normal levels. A cholecystogram and upper gastrointestinal series were obtained. These showed only faint visualization of the gallbladder, but this proved sufficient to establish the presence of gallstones. The upper gastrointestinal series showed a slightly widened duodenal C-loop, but no other abnormality. The slightly tender suggestion of an epigastric mass seemed localized to the body of the pancreas.

Early operation for correction of the demonstrated biliary disease was advised. The patient agreed, but wished to return for this after a few weeks at home. She was discharged after careful instruction in a bland ulcer diet with moderate fat, and was advised to continue taking antacids and belladonna at home.

Feeding must be resumed in these patients with extreme caution, since this is a potent stimulus to pancreatic secretory activity. A bland diet is essential to avoid the peaks of pancreatic stimuli occasioned by the entry of acid gastric content into the duodenum. For the same reason, stimulants of gastric acid, such as coffee, tea and roughage, are avoided, and antacids and belladonna prescribed. The same situation that precipitated the attack of acute pancreatitis in the first place, whatever it is, remains uncorrected, and there is real danger of re-exacerbation of this disease.

The persistence of serum amylase elevation while clinical signs of disease are subsiding suggests the presence of a loculated collection of pancreatic secretions in the abdomen, or a developing pseudocyst. This was confirmed by palpating an indurated, sometimes tender, area deep in the epigastrium. Many of these occurring after an attack of acute pancreatitis will spontaneously subside without specific therapy. Those that persist or enlarge are usually associated with persisting pancreatic ductal obstruction, and operation will be required. Upper gastrointestinal series is clearly indicated during convalescence to define the size of this mass, as a baseline, so that its course over the next few months can be followed.

Gallbladders frequently do not concentrate dye within three weeks after the acute attack of pancreatitis, and yet on later examination prove to be normal. Non-functioning by dye tests cannot be taken as evidence of biliary disease during this interval. Neither can the moderate and evanescent jaundice coming on during the acute attack be considered to indicate biliary disease, since edema of the pancreas alone can produce this. However, it is extremely important in the prevention of future attacks that gallstones be eliminated. A cholecystogram during hospitalization is often worthwhile, therefore, but only if sufficient dye is concentrated to demonstrate stones when present. One-half to two-thirds of all patients first seen with acute pancreatitis prove to have gallstones. They should be looked for in all such patients.

Corrective biliary surgery can be undertaken very shortly after pancreatitis subsides. It has been carried out on the same hospitalization and within two weeks of acute pancreatitis in 20 per cent of our patients, with no increase in mortality or morbidity. The common duct is always explored. Prognosis must remain guarded for this woman until the biliary disease is corrected. When this disease is found and eliminated, 90 per cent of patients will remain free of further attacks. If biliary disease is not demonstrable, at least one-third of patients have no further trouble. In those who do, chronic pancreatitis with pseudocysts, or ductal obstruction, must be suspected.

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Surgery Court Cases

HOWARD NEWCOMB MORSE,* *Chicago, Illinois*

MAYERS VS. LITOW

District Court of Appeal of California

316 P. 2d 351

This action was taken by a man and wife for damages predicated upon the alleged malpractice of a surgeon arising out of a thyroidectomy performed upon the wife. The Superior Court of Los Angeles County, California, granted a judgment of non-suit in favor of the surgeon, and the plaintiffs appealed. The District Court of Appeal of California reversed the judgment in favor of the surgeon entered by the lower court.

The surgeon had removed a nodule ("a growth within the thyroid gland," as he characterized it) on the patient's neck. He had been of the opinion that it was serious and required surgery since it was what he termed a "pre-malignant lesion." After the operation there was no movement of the left vocal cord.

The plaintiffs based their claim of negligence on the part of the surgeon upon two theories: (1) he was negligent in his diagnosis that the operation was needed, and (2) he was negligent in performing the operation.

In disposing of the first theory, the Court stated that while "the nodule which defendant . . . removed from [the patient's] neck was not cancerous . . . there was no test known to determine in advance whether or not the growth was cancerous until it was taken out."

Of the other theory, the Court declared: "In support of their second theory of negligence plaintiffs introduced extensive evidence tending to show that . . . (the surgeon) might have severed the recurrent laryngeal nerve during the operation. Since all the medical experts were of the opinion that this nerve should not be severed during the type of operation performed upon [the patient], a severance of that nerve would indicate that the doctor failed to exercise reasonable care in performing the operation. If there was sufficient evidence indicating that . . . (the surgeon) severed the nerve or that he otherwise failed to exercise reasonable care in performing the operation, then the case should have been allowed to go to the jury . . . there was sufficient evidence to permit the case to go to the jury."

DAVIS VS. BONEBRAKE

Supreme Court of Colorado

313 P. 2d 982

This was a malpractice action in which the plaintiff obtained a favorable verdict against two surgeons who sought reversal of an adverse judgment rendered in the District Court of Denver County, Colorado. According to the complaint, a surgical sponge or insoluble pack had been left in the plaintiff's abdomen after the performance of a hysterectomy.

The case is both interesting and important because it deals with the fraudulent concealment by the surgeons of the presence of the sponge left in the body of the patient, and the degree of evidence sufficient to prove fraudulent concealment. The Court explained: "Testimony to the effect that plaintiff was very sick after the August operation; that a number of doctors examined her; that she was again subjected to surgery in the identical anatomical area without disclosure at the time of why it was performed; that she was told afterwards the necessity for the second operation would in the future be divulged to her; that she sought information from the doctors, and on two occasions from . . . (the instrument nurse), concerning the exigency requiring the operation; and that on her second quest

* Counsellor at Law, Member of the Bar of the Supreme Court of the United States of America.

in October . . . (the instrument nurse) informed her that the doctors removed a sponge from her abdomen, presented a fact situation for the jury to consider, weigh and determine. A question of fraudulent concealment evolves from this testimony."

If the filing of the malpractice action would ordinarily have been too late so as to be outlawed by the statute of limitations, proof of fraudulent concealment has the effect of tolling (suspending) the statute of limitations so that the time period within which suit must be brought does not begin to run until the patient has knowledge of the foreign object in her body. The Court held that "belief" on the part of the patient that a foreign object had been left by the surgeon in her body did not constitute "knowledge" so as to prevent the tolling of the statute of limitations. However, the Court reversed the judgment of the *nisi prius* court on other grounds not germane to this discussion, and remanded the case with directions to the lower court for a new trial.

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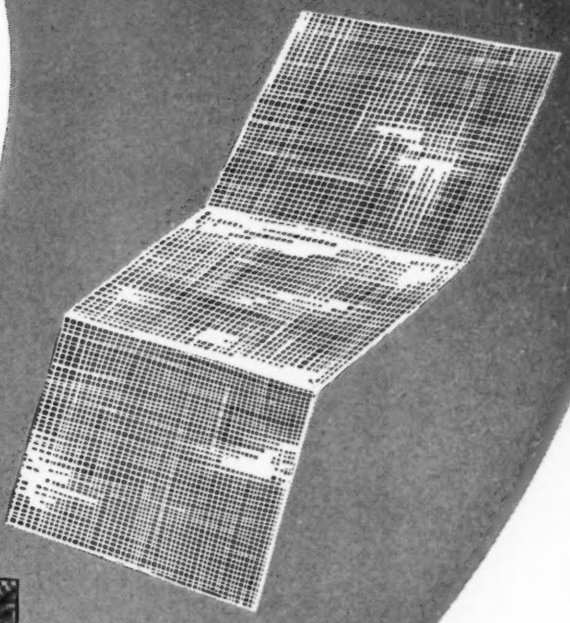

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***Koch, R., and Donnell, G.: California Med. 87:313, 1957.**

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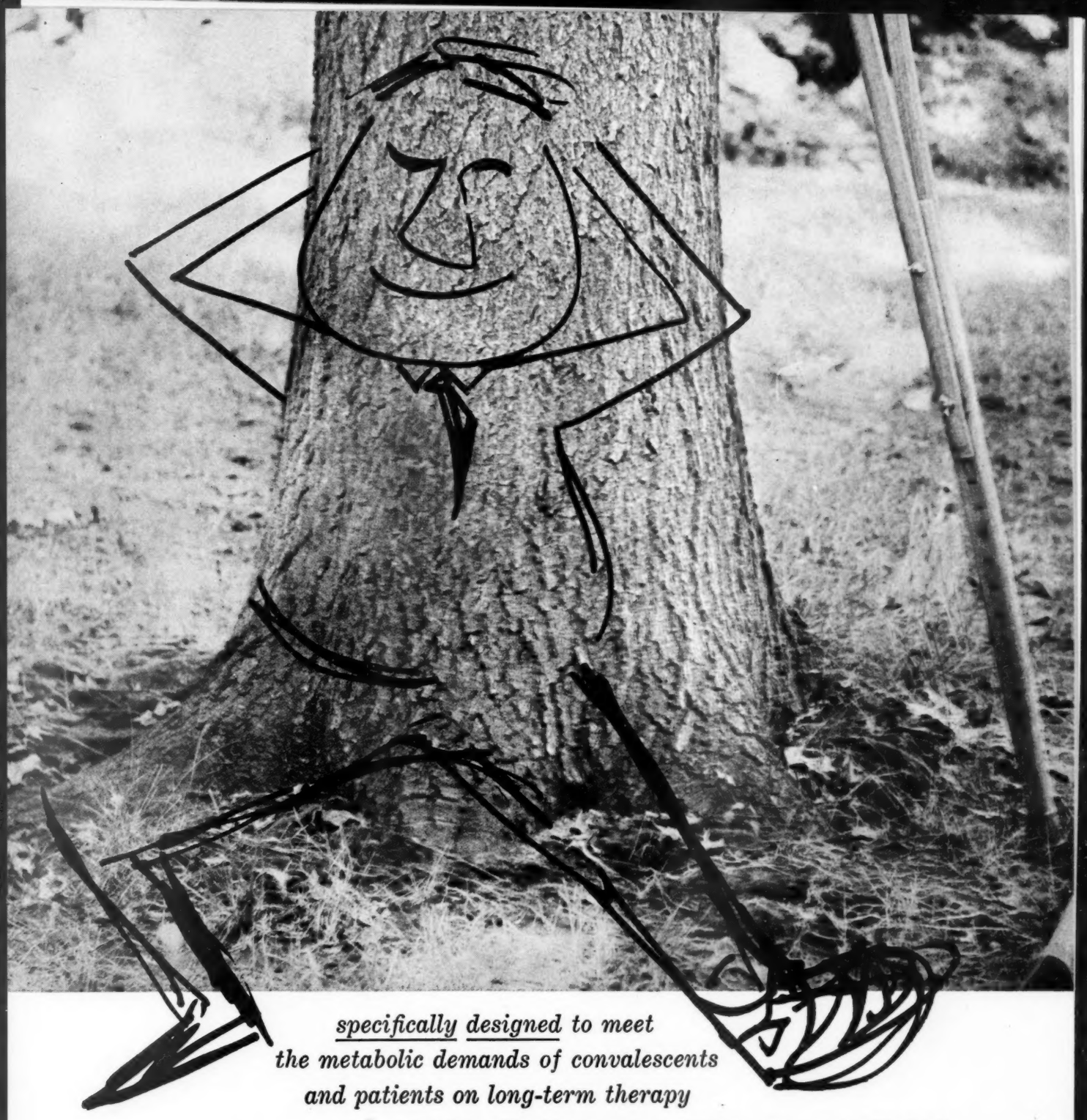

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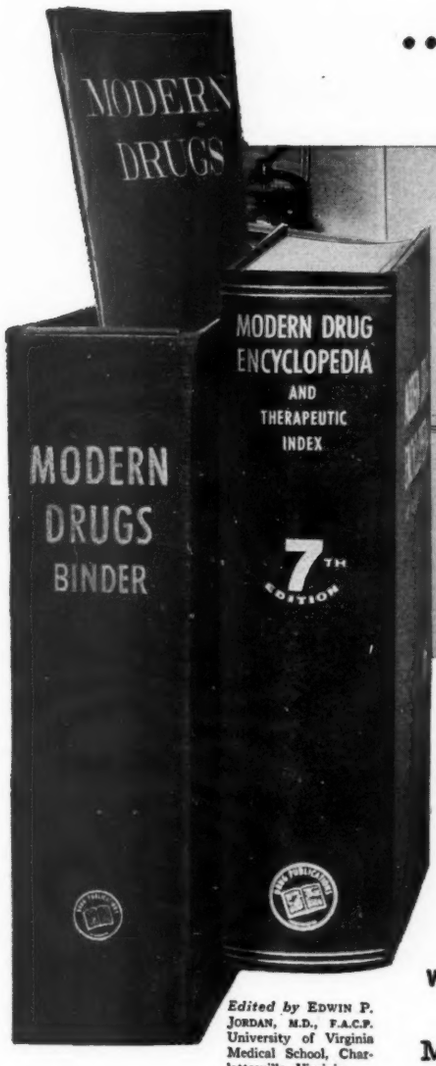

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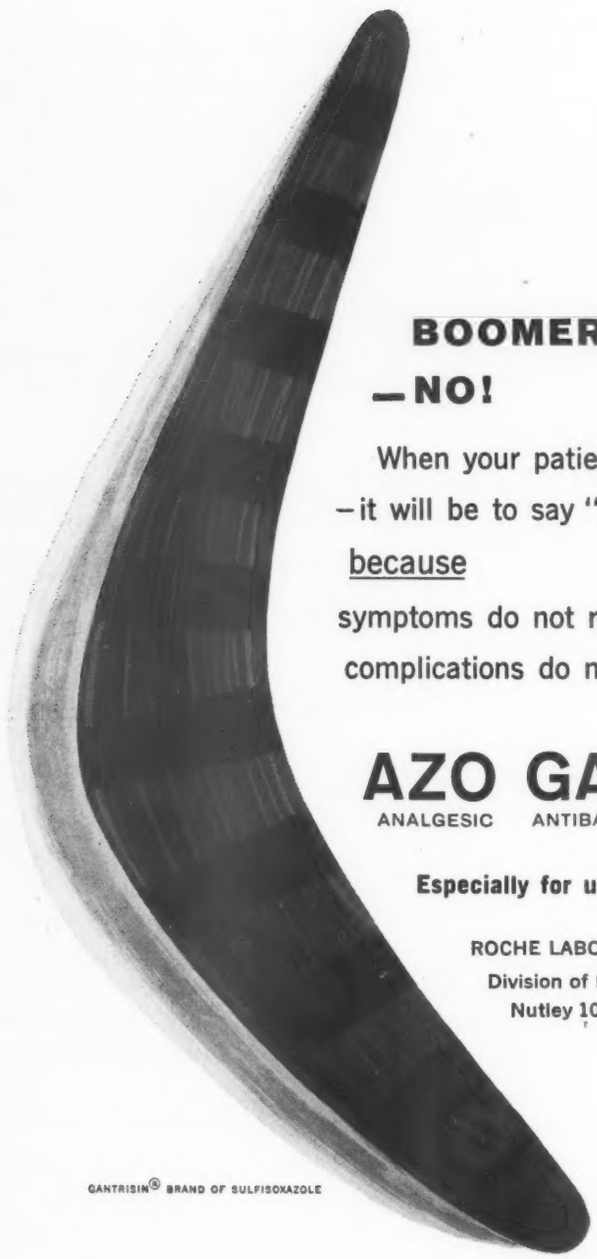

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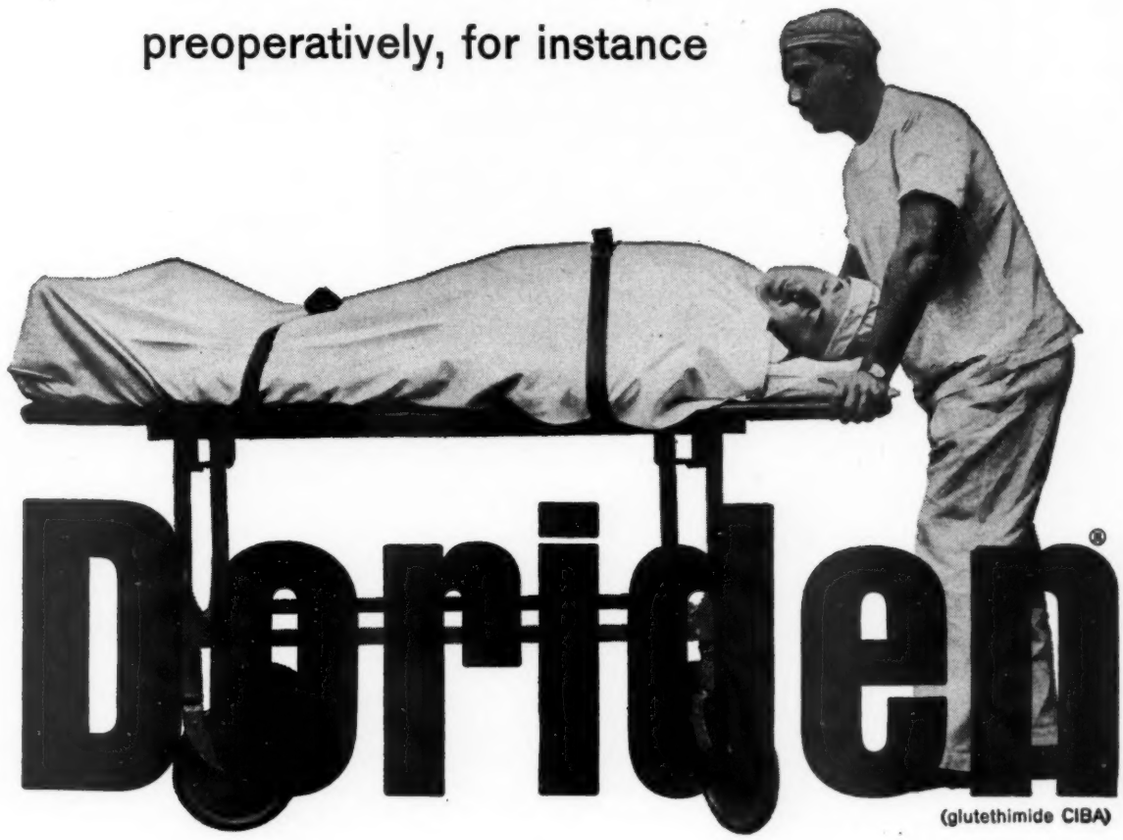

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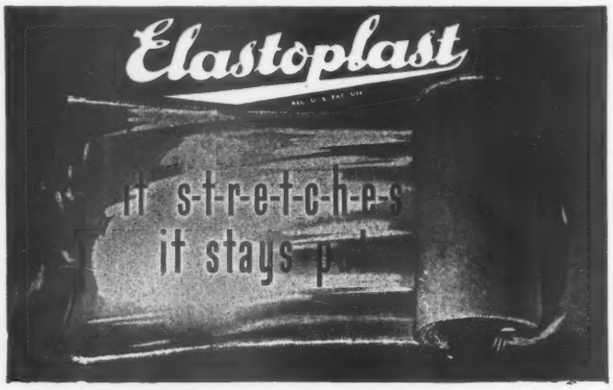

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PUBLISHED REFERENCES: 1. Carpenter, E. P.: Southern Medical Journal 51:627, 1958. 2. Forsyth, H. F.: J.A.M.A. 167:163, 1958. 3. Little, J. M., and Truitt, E. B., Jr.: J. Pharm. & Exper. Therap. 119:161, 1957. 4. Morgan, A. M., Truitt, E. B., Jr., and Little, J. M.: J. Am. Pharm. Assn., Sci. Ed. 46:374, 1957. 5. O'Doherty, D. S., and Shields, C. D.: J.A.M.A. 167:160, 1958. 6. Park, H. W.: J.A.M.A. 167:168, 1958. 7. Truitt, E. B., Jr., and Patterson, R. B., Proc. Soc. Exper. Bio. & Med. 95:422, 1957. 8. Truitt, E. B., Jr., Patterson, R. B., Morgan, A. M., and Little, J. M.: J. Pharm. & Exper. Therap. 119:189, 1957.

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CONDITION	NO. PATIENTS	RESPONSE			
		"marked"	moderate	slight	none
STUDY 1[1]					
Skeletal muscle spasm secondary to acute trauma	33	26	6	1	—
STUDY 2[2]		"pronounced"			
Herniated disc	39	25	13	—	1
Ligamentous strains	8	4	4	—	—
Torticollis	3	3	—	—	—
Whiplash injury	3	2	1	—	—
Contusions, fractures, and muscle soreness due to accidents	5	3	2	—	—
STUDY 3[5]		"excellent"			
Herniated disc	8	6	2	—	—
Acute fibromyositis	8	8	—	—	—
Torticollis	1	—	—	1	—
STUDY 4[6]		"significant"			
Pyramidal tract and acute myalgic disorders	30	27	—	2	1
TOTALS	138	104 (75.3%)	28 (20.3%)	4	2

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"In the author's clinical experience, methocarbamol has afforded greater relief of muscle spasm and pain for a longer period of time without undesirable side effects or toxic reactions than any other commonly used relaxants . . ."[2]

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"In no instance was there any significant reduction in voluntary strength or intensity of simple reflexes."[6]

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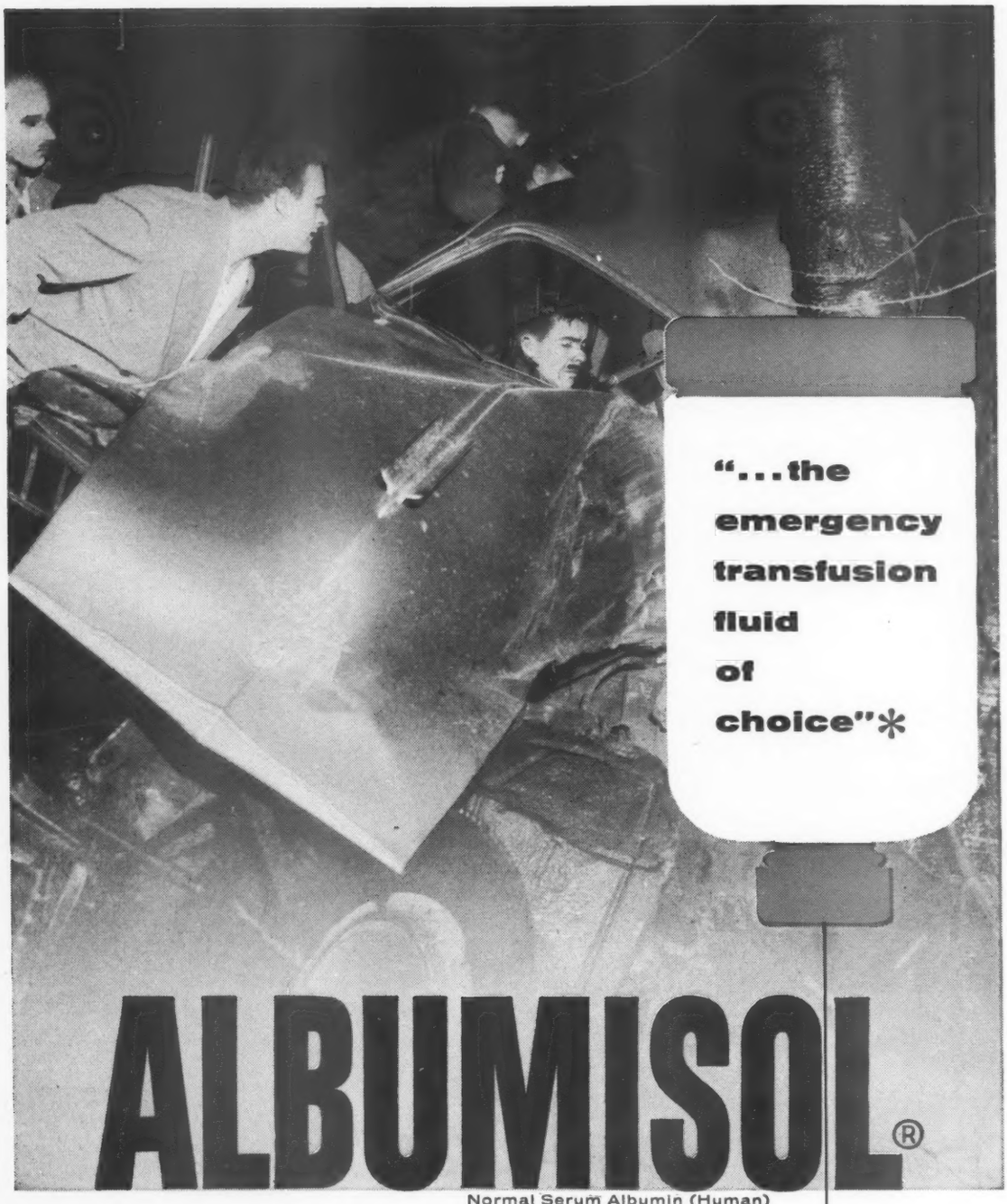

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*Janeway, C.A.: Quart. Rev. Med. 9:153 (Aug.) 1952.

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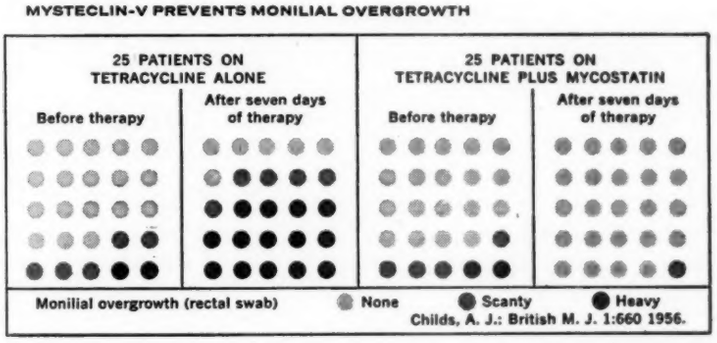

Childs, A. J.: British M. J. 1:660 1956.

clinical report[1]

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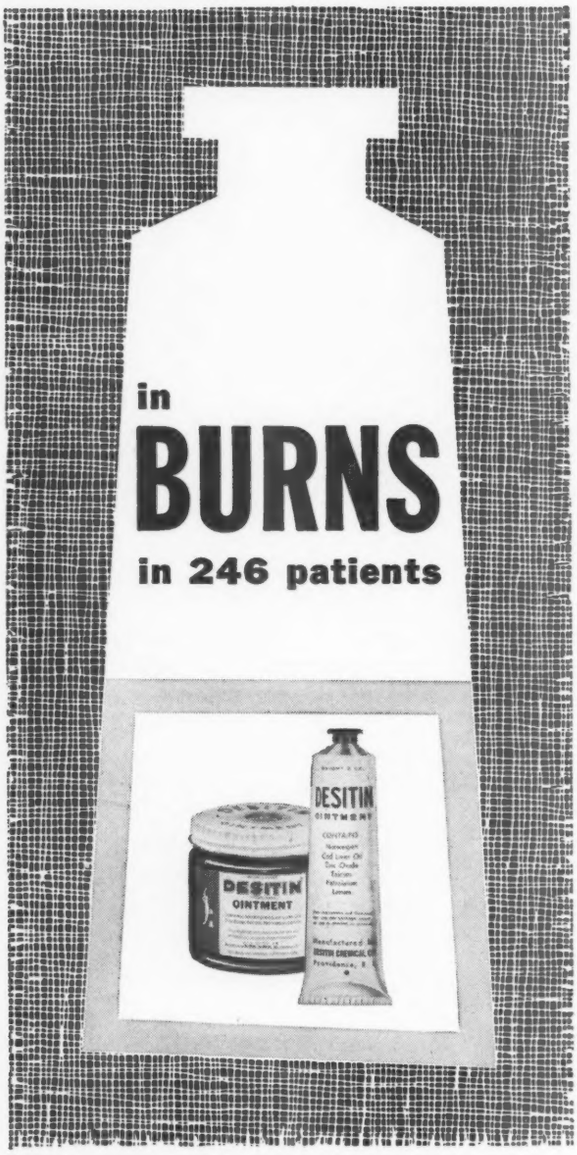

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1. Grayzel, H. G. and Schapiro, S.: Western J. Surg. 64:558, 1956.

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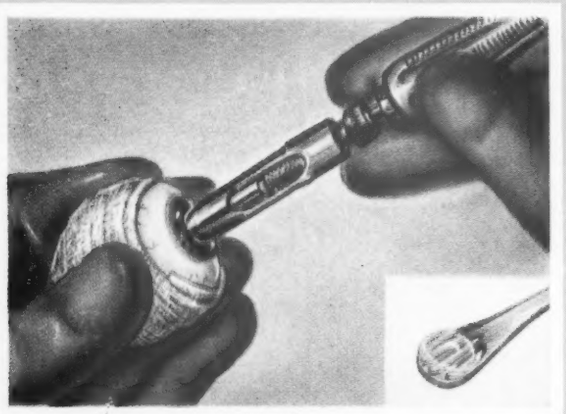
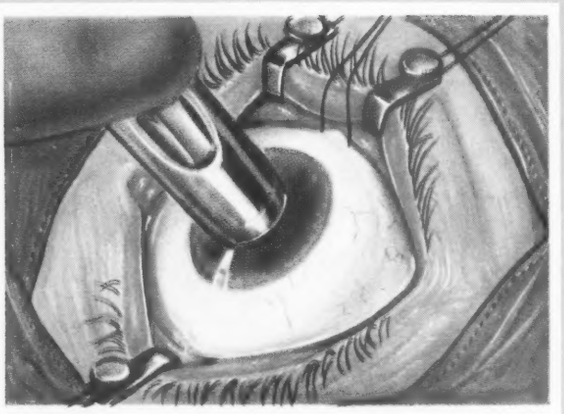
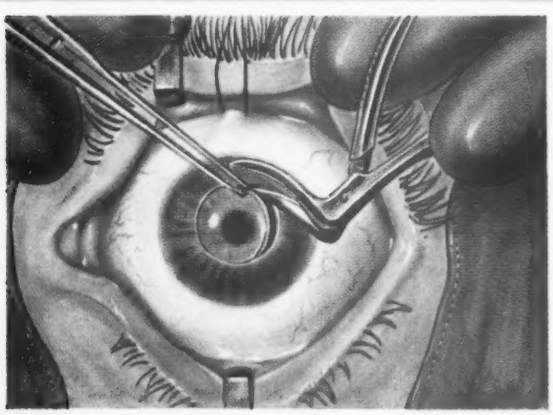
KEY ADVANCES IN OPERATIVE TECHNICS*—*Corneal Graft*[1]



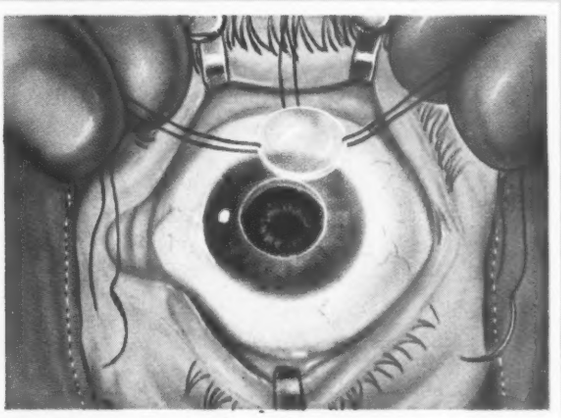
1. A corneal graft of appropriate size is cut from the donor eye with a Castroviejo trephine. Inset shows excised button of healthy corneal tissue.



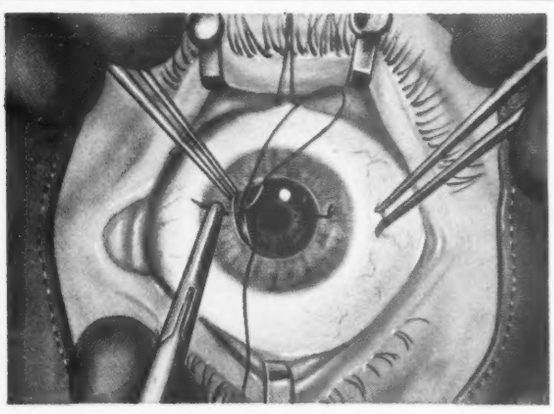
2. The site of excision of the patient's diseased cornea is marked with a trephine of the same size as that used to obtain the donor graft.



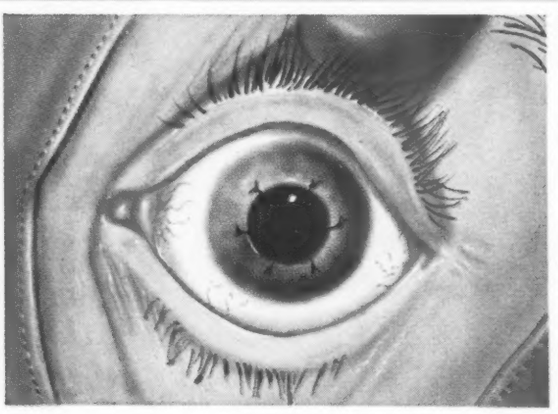
3. As soon as the anterior chamber is entered, the trephine is withdrawn and the excision is completed with Castroviejo curved scissors. This procedure avoids damaging the iris.



4. Following removal of the diseased corneal tissue, the donor button is brought to the open incision with two preplaced sutures. The graft is then accurately positioned.



5. Sutures are placed with Castroviejo No. 82 stainless steel Grishaber needle and 6-0 silk. They pass through the epithelium and stroma and are continued through the recipient cornea and tied.



6. Appearance of completed keratoplasty after placing of final four sutures. Air may now be injected into anterior chamber to minimize the development of anterior synechia.

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1. Castroviejo, Ramon, *Trans. Am. Ophth. Soc.*, Eighty-fifth Annual Meeting, Hot Springs, Virginia, 1949.

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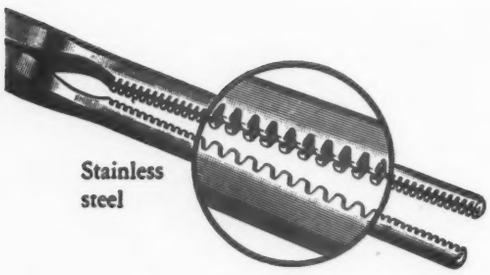

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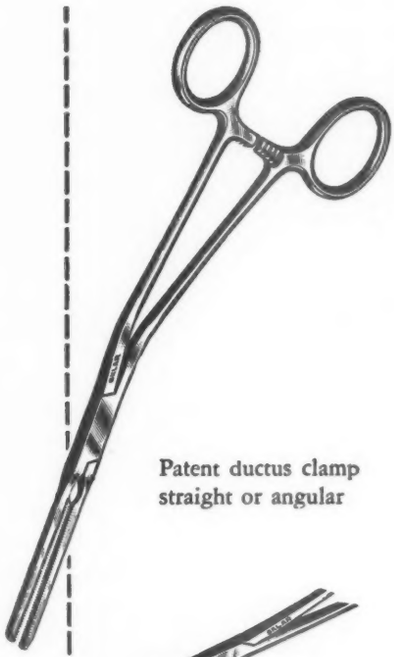
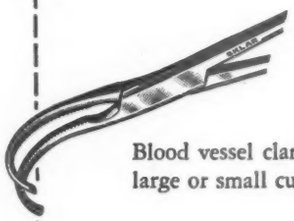


Patent ductus clamp
straight or angular

Satinsky
vena cava clamp



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Coarctation clamp
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Bronchus clamp, angular

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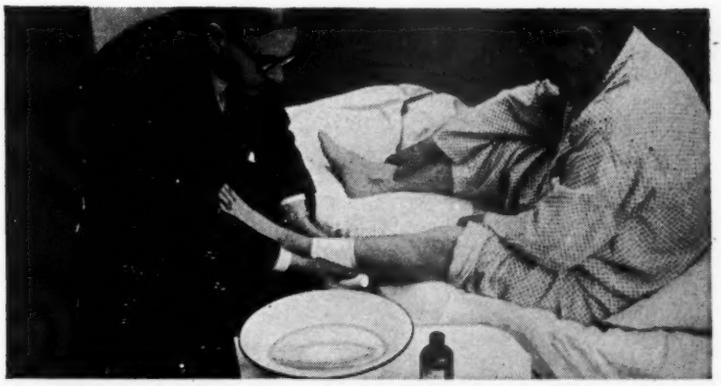

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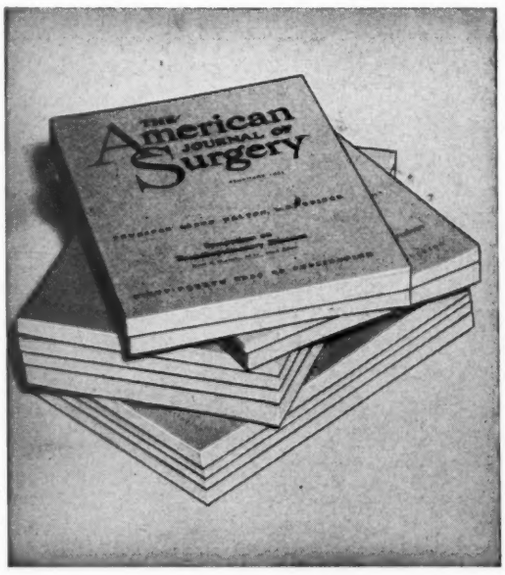

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NOTES AND QUOTES

COSA-TETRACYN FOR GYNECOLOGIC INFECTIONS. Forty-four of fifty patients with acute and chronic gynecologic infections were "cured or definitely improved" following Cosa-Tetracyn therapy, report M. L. Stone, A. Sedlis, J. Bamford and W. Bradley, physicians of the New York Medical College. The drug proved effective against several tetracycline-resistant strains, the investigators reported.

Although twenty-eight patients had been treated unsuccessfully with other antibiotics, state the authors in a recent issue of *Antibiotic Medicine and Clinical Therapy*, eighteen of this group were cured and seven improved following Cosa-Tetracyn therapy. Four of the cured patients had failed to respond to tetracycline without the glucosamine component.

Nearly half the patients in this study (twenty-two) were treated for infection following incomplete abortion, with nineteen responding to Cosa-Tetracyn. Treatment was usually completed within two days for these patients and the authors state that the "number of those cured was greatest during the first forty-eight hours of treatment."

Twenty-two other patients were treated for postoperative wound infection or pelvic inflammatory disease. Nineteen responded to Cosa-Tetracyn, with four days' average treatment.

Daily dosage schedule was four 250 mg. capsules of Cosa-Tetracyn. One patient received an initial dose of 500 mg. The new drug was well tolerated and side effects were limited to mild rash and pruritus in two patients. Nausea and diarrhea occurred only in the one patient with carcinoma of the cervix.

PHOTOGRAPHIC MEASUREMENT OF OXYGEN IN BLOOD VESSELS. *A research project at the Duke University Medical Center has resulted in the development of a new use for photography.*

Working with a special "eyeground" camera plus red and infrared light, Duke researchers have developed a novel photographic technic for measuring the amount of oxygen in blood as it flows through blood vessels of the eyeball.

The ultimate aim of this work is to provide data about the body's state of health and to use the process as a research tool for studying blood vessel changes that occur in various illnesses.

The technic was originated by Dr. John B. Hickam, Professor of Medicine, and Miss Regina Frayser, Research Associate, at the Medical Center. Their work is being conducted under contract with the School of Aviation Medicine, U. S. Air Force.

Dr. Hickam explained that the eye has long been important in physical examinations because it provides a "window" through which physicians can see blood vessels that lie along the back of the eyeball. The amount of oxygen that the eye or any other organ takes from the blood passing through it offers a clue to that organ's condition.

TRANQUILIZER FOR SENILE PSYCHOSES. Clinical and pharmacological studies demonstrated that Nicozol with Reserpine, Drug Specialties, Inc. (pentylenetetrazol 100 mg., niacin 50 mg. and reserpine 0.25 mg.) provides a safe and highly effective treatment for senile psychoses. This medication combines the analeptic and vasodilator actions of Nicozol with the tranquilizing effect of Reserpine. With this therapy many patients who otherwise would have required institutional care were managed at home with a minimum of nursing attention.

In a series of seventy-five patients with senile psychoses treated with Nicozol with Reserpine, sixty-five (87 per cent) showed improvement. The therapy afforded relief of agitation and restlessness together with improved memory, behavior, sociability, appearance and tidiness. Symptoms of confusion, aggressiveness, hostility and disorientation were relieved.

The only side effect was transitory flushing of the skin in two cases. There were no convulsions in any case. Pharmacological studies on mice indicated that reserpine does not potentiate orally induced pentylenetetrazol convulsive seizures.

BETTER DIABETIC CONTROL. *Although diabetes is still incurable, it is no longer the threat to life that it used to be, the Health Information Foundation reported recently.*

In a recent issue of its monthly statistical bulletin, Progress in Health Services, *the Foundation recalled that "Forty years ago, a medical diagnosis of diabetes was the equivalent of telling a patient he would soon die."*

"Nowadays," the Foundation continued,

CONTINUED ON PAGE 54

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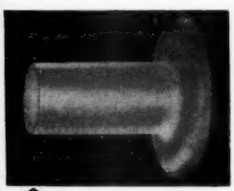

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Diabetes mortality hit its peak in this century in 1940, when the death rate reached 26 per 100,000 persons. Since then it has declined to about 16 per 100,000 population in 1957. Even so, according to the Foundation, diabetes ranked eighth among the leading causes of death and was responsible for an estimated 27,000 deaths or 2 per cent of all fatalities last year.

A NEW DRUG. An old problem with barbiturates—overdosage by accident or in suicide attempts—can now be combatted with a new drug named megimide.

Introduced to the medical profession in the United States by Abbott Laboratories, megimide acts on the central nervous system as a stimulant. It not only is effective in barbiturate poisoning but also in restoring normal reflexes following the use of barbiturate anesthetics.

Abbott reports that extensive clinical studies showed that this drug acts swiftly on vital reflexes, especially respiration. In this respect there is evidence that it is an improvement over older agents. Another advantage is that effective dosage is appreciably below amounts that could cause convulsions.

Administered through the vein, megimide is a crystalline synthetic compound in solution form. A very small amount may produce the desired effect following anesthesia, while larger doses may be required in severe barbiturate poisoning, particularly for victims in a coma.

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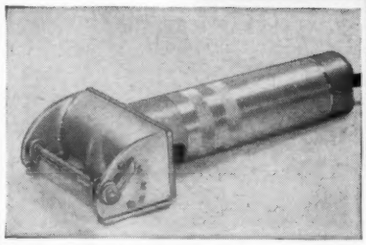

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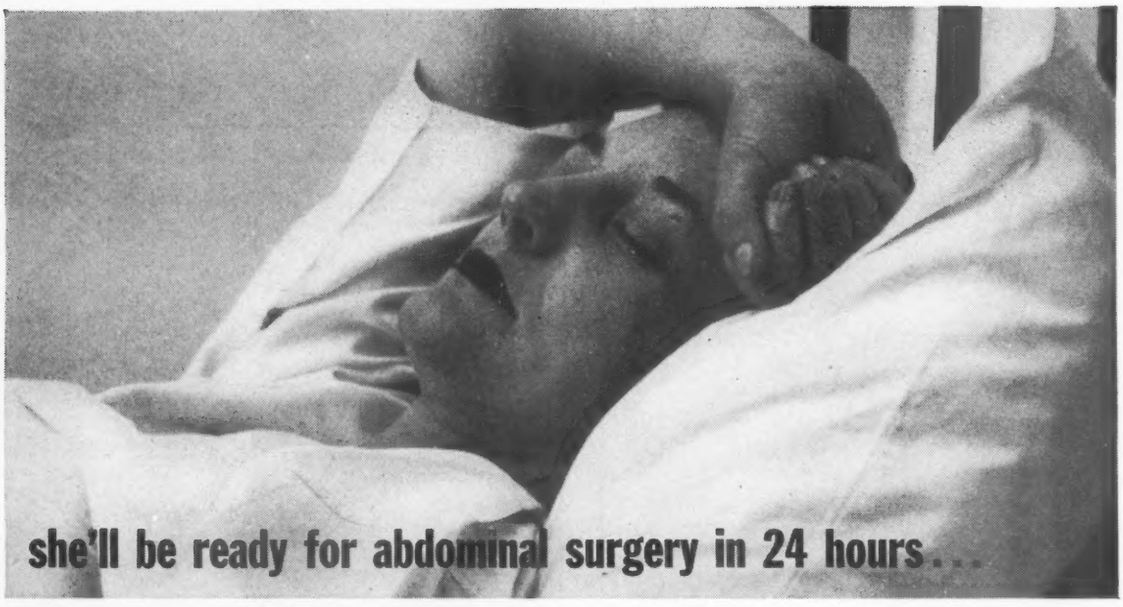

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